

*Horologiographia.*

THE  
Art of Dialling:

TEACHING,

*A N E A S I E A N D*

perfect way to make all kinds of Dials vpon  
any plaine plat howloeuver placed.

With the drawing of the twelue Signes, and  
*houres inequall in them all.*

Whereunto is annexed the making and vse of other Dials  
*and Instruments, whereby the houre of the day and night is knowne:*

Of speciall vse and delight, not only for Students of the Arts Mathe-  
maticall, but also for diuers Artificers, Architects, Surueyours  
*of buildings, free-Masons and others.*

By THOMAS FALE.



*AT LONDON,*

Imprinted by FELIX KINGTON, dwelling in  
Pater-noster-Row. 1633.





SINGVLIS ARTIVM MATHE-  
MATICARVM STUDIO SIS IN  
CELEBERRIMA CANTABRIGIENSI  
ACADEMIA, THOMAS FALVS EIVSDEM  
ALVMNVS, ET VERÆ MATHeseOS  
STVDIOSVS, EXIGVVM HOC  
GRATI ANIMI MO-  
NVM ENTVM DD.

ANNO. 1593.

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Simonis Muri ad lectorem

*Carmen.*

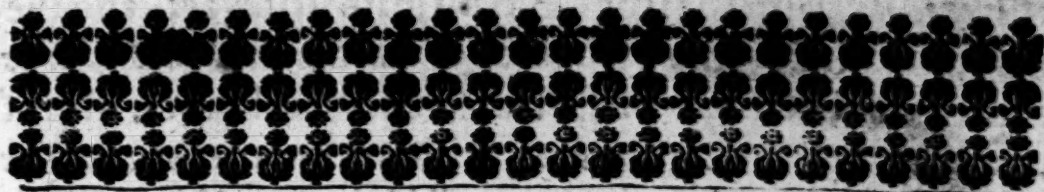
*Scire cupis certa cur machina tangitur umbra?*

*Et brevis atherum linea signat iter?*

*Hac, licet evolvās, facili praecepta libello*

*Tradita, sed voto non leniora tuo.*





To the friendly Readers, and namely,  
to such as bee well-willers to the  
*Mathematikes.*

**T**He Arts Mathematicall (gentle Reader) in regard of their antiquity and excellency, may bee compared with any other of the liberall Sciences whatsoeuer. For *Seth*, who liued in the first age of the world, is commended of *Iosephus*, and *Abraham* of *Berosus*, to haue beene skilfull masters in these mysteries. And the very name importeth that in olde time these of all other were esteemed worthy to bee taught, being called for their excellency *Mathemata*, that is, Sciences meet to be learned. These be *Aritmetike*, *Geometry*, and *Astronomy*, from which this Art of Dialling taketh his beginning: a knowledge also ancient and necessary, and therefore practised by Princes and famous men of former Ages. The first Diall that histories remember, is *Lib. 2. cap. 20.* of the *Kings* in the holy Scripture, where the Lord turned the Sunne backe 10. degrees for *Hezekias* sake, whereby it had gone downe in the Diall of *Abaz*. This *Abaz* was King of *Ierusalem*, and reigned in the 3200. yeere after the creation of the World, and in the first Olympiade of the Grecians. Afterward, as *Plinie* writeth, *Anaximenes Milefius* the scholar of *Anaximander*, first found out the reason and proportion of shadowes amongst the Lacedemonians, and there taught the Art of Dialling, who liued 200. yeere after the raigne of *Abaz*, and was a famous Philosopher in Greece before *Platoes* time, as *Diogenes Laertius* reporteth. But some affirme, that it was *Anaximander* himselfe that found out this Art, and set forth the first Mappe of the Earth.



## To the Reader.

Lib. 2.

*Herodotus* saith, that the Grecians learned this art, and the diuision of the day into 12. houres, of the Chaldeans. *Diodorus* writeth that one *Hyperion* first obserued the houres. But if wee may belecue *Macrobius*, it seemeth that this Science came frō the Egyptians: for they called the Sun *Horus*, which by his motion limiteth to each houre his appointed time.

Lib. 9.

*Vitruvius* rehearseth sundry inuentors of this Art of Dialling, as *Berosus* the Caldean, *Aristarchus*, *Samius*, *Endoxus*, *Theodosius* with others, who were renowned, and liued many yeeres before the birth of Christ. I need not here remember *Architas Tarentinus*, who by art made a Doue of wood to flie in the ayre: neither *Archimedes*, who defended *Syracusa* against *Marcellus*, and affirmed that if he had a place to stand on, hee would moue the earth with his engines: both of them no doubt skilfull in this Science.

Plutarch. in  
Marcel.

It was long after the inuention that this Art was known in Rome: for in the 12. tables was only mentioned the rising and setting of the Sun, and after certaine yeeres the midday was added. Then in the first *Punike war* the Romanes obtaining victory, there was a Diall brought amongst other spoyles out of *Sicily*. But in proceſſe of time they began to bee more common in Rome: for 100. yeeres before *Ciceroes* time, the parasite in a Comedy, being hungry, spake against the multitude of Clockes and Dials which were then in the City, *Optans ut suus cuique uenter sit horologium.*

Lib. 36. c. 10.

*Plinie* also telleth of a Diall placed in the field of *Flora* at Rome, which by the space of 30. yeeres had not agreed with the Sun; & the reason was, as he thought, because that either the Sun had taken a new course, or else the earth was slipped from his Centre, wherein at the first it stood, or the stile was put awry by the shaking of the City. Since which times learning spreading it selfe into diuers parts of the world, this Art hath been amongst the rest in great account.

Concerning the profit of this Art, daily experience teacheth, how needfull it is in a well ordered Common-wealth, seeing nothing can be done in due and conuenient season, where this Science is neglected: for the diuision of the day  
into

## To the Reader.

into certaine parts or houres. (which this Art teacheth) doth limit and allot to each action his due time. This Art being then so ancient, and the vse so necessary, I trust none will thinke this labour superfluous, vnlesse they be rude without ciuility, or such as haue alwaies at hand a Diall of natures framing, of whom this verse seemeth to be made:

*Sit tunc ad solem stat natuo nasus bians*

*Morus.*

*Ore bene ostendus dentibus hora quota est.*

Many haue promised (but none as yet performed) to write of this Science in our English tongue, which hath bin published in other languages, as *D. Record* long since, *M. Digs*, *M. Blagrawe* with other, who, if they would take the paines, I know could doe it with great commendation.

Diuers haue written hereof in the Latin tongue, as *Munster*, *Schonerus*, *Orontius*, *Witekindus*, *Clavius* and others: yet euery one differing from other in precept. Some teach the making of Dials by the helpe of the Globe, as *Gemma Frisius*: some by the Astrolabe, as the same *Gemma Frisius* and *M. Blagr.* which instruments euery man haue not. Some vse the table of *Sines* and *Arithmetike*, as *Witekindus*, which way as most plain & casie, is obserued in this booke; though in some kinds for want of triall *Witekindus* deceiued himselfe. *Munster* vseth a *Rectificatory* with a circle, which is vnfit for small plats, and faileth in greater, without great heede. *Schoner* wandreth in a wildernesse of lines, that a man knowes not where to begin, or when to end. *Ulmer* hath not the Delineation of all kinds.

Other some obserue the rules of Geometrical proportion which order also we thought to haue obserued in all kinds, as we haue done in the South & North erect declining, but that sundry precepts of the same thing would haue bred tediousnes and trouble to the learner, and the cutting of the Figures would haue bin very chargeable. By meanes wherof we contented our selues with this one way here set downe, not doubting, but that euery one with small paines may attaine to the making of all kinds of Dials in this booke expressed. As for a great part of them, euery Artificer may easily vnderstand.



## To the Reader.

Onely thus much I aduertise the vnlearned, that they must acquaint themselves with some few Mathematicall principles, as to know what the Eleuation of the Pole meaneth, how a squire line is to bee drawne, and such like, which (if they want a teacher) they may sufficiently learne by themselves out of *Records Castle*, his pathway and ground of Artes, published in the English tongue: for these tearmes could not bee auoided, neither plainly described without much tediousnesse.

Wee haue here added also Examples and Figures to euery kinde, that so the precepts might appeare more plaine and easie: so that there is no plaine plat or wall, howsoeuer it standeth, or be placed either Declining, Reclining, or Inclining but by the helpe of this Booke you may draw a Diall vpon it.

If any man complaine of obscurity, hee must know, that *Difficilia quæ pulchra*, and yet small paines ouercommeth all.

The making of the Horologicall Cyindre, and the Ring, with some other Instruments, wee haue presently omitted, partly for their curiosity in cutting and delineation, and partly because (if occasion serue) wee will entreate of these kindes of Horologicall Instruments by themselves, together with the making of all kindes of plaine Dials in this booke, prescribed by the way of Geometricall proportion.

In the meane while (gentle Reader) committing  
this booke to thy fauourable acceptation,  
and thy selfe to the protection of  
the Almighty, I end.

THOMAS FALE.

## To my louing kinsman Tho. Osborne.



His booke, which seuen yeeres since, was in a manner perfected (as you know) doth now upon iust occasion present it selfe to the view of the world: wherein you haue taken such paines for the triall of each example, that I thinke none can finde any great fault, but such as can see farre into other mens faults, and forget their owne. For after we found some precepts in Witkindus to be false, we were enforced to try and examine with great care each figure and example in the Sun. And therefore if any receiue benefit by this our triall, I would you should haue your due praise you deserue.

I haue altered some few things, and added the making of the South & North Erect declining Dials, by the way of Geometrical proportion: because those kindes be most in vse, and I would the learner should haue his choise of the easiest way.

The grauer of the Figures was one M. Iod. Hondius, who hath shewed himselfe an excellent workeman in the great Globes set forth by M. Mullineux, and the Maps of England for M. Camdens booke: and whether he hath performed like diligence in these, I referre it to your selfe to iudge. If any be desirous to haue the Instrument mentioned in the beginning of this booke, for the tryall of plasse, I hope you will helpe them to it: for being of your owne inuention, I know none so fit as your selfe to make it: on which Instrument also, it were conuenient to draw the quadrant Horologicall that so it might serue for diuers vses.

I trust you will not be offended, in that I leaue vnder our names this smal monument vnto the world, as a speaking witnesse of our thankfull hearts to this our Country, and a testimony of our affection toward the Arts Mathematicall. Thus beseeching the Lord (who hath endued you with extraordinary knowledge in all Mannall Sciences) to finish that good worke of his heauenly grace already begun in you, to his glory and your owne comfort, I take my leaue. Commend me many times to your selfe, and all our good friends. From London, Iannary 3. 1593:

Yours assuredly, T.F.



## Aduertifements to the Reader.

**N**Ote alwaies, that in euery Diall the one end of the Stile must bee placed directly towards the North Pole, and the other end towards the South Pole: for about these two starres the whole heauens are moved, they remaining immoueable. The North Pole is a starre in the North part of the heauen, being raised aboue the earth or our Horizon 52.4. And this changeth his height, if you goe Northward or Southward one degree in 60. miles: but Eastward or Westward it altereth not. The Eleuation of the Pole is the height of this starre aboue the earth.

Obserue also, that the Substile is the line or place ouer which the Stile or Gnomon in your Diall directly hangeth. The space betweene the Stile and Substile is the iust height thereof.

One line cutteth another squirewise, when they make right and equall angles.

The Contingent or touch line, is that which is drawne by any point of another line or circle, so that it toucheth the same: and this line commonly in all Dials is drawne squirewise to the Substile.

A quadrant is the fourth part of circle.

The Meridian and twelue a clocke line are all one.

I call these lines parallell, which are euery where of like distance one from another: example whereof you may see in the East and West diall, where all the houre lines be parallell.

You may make all kinds of plaine Dials vpon one stone, if you prepare it first to be square like a Dye, and then take off the eight corners, and all the sharpe sides, so shall you haue 25. plaine plats besides the base, or foote whereon your Diall must stand.

If any be desirous to haue this Instrument ready made, let him enquire at the Printers, and he shall heare of them.

THE



**The making of an Instrument to  
finde out the situation of any plat or  
Diall, and to place them al-  
ready prepared.**

**CHAP. I.**



**H**owasmuch as it is necessary be-  
fore you can draw any Dial, to  
know how your plat is already or  
ought afterward to be placed, it  
shall bee expedient to shew the  
making and vse of an Instrument  
whereby you may examine and  
try all plain plats, and place all  
dials being ready made and pre-  
pared.

Provide therefore an halfe circle of Pearetree, Walnut-  
tree, Box, or any other close grained and solid wood, being  
well seasoned, so that the alteration of the weather at any  
time may not make it change from the first proportion ther-  
of. Let it be perfectly tryed on both sides of an even thick-  
nesse, halfe or three quarters of an inch thick or more if you  
will, and sixe or eight inches broad as you thinke good. The  
edge or side A. B. must be very right. When draw the Line  
C. D. three quarters of an inch equally distant from the side  
A. B. place one foot of your compasses in the centre E. which  
is the midst of the line C. D. and with the other draw halfe a  
circle from C. to A. divide it into two equall parts or qua-



## Aduertifements to the Reader.

**N**Ote alwaies, that in euery Diall the one end of the Stile must bee placed directly towards the North Pole, and the other end towards the South Pole: for about these two starres the whole heauens are moved, they remaining immoueable. The North Pole is a starre in the North part of the heauen, being raised aboue the earth or our Horizon 52.4. And this changeth his height, if you goe Northward or Southward one degree in 60. miles: but Eastward or Westward it altereth not. The Eleuation of the Pole is the height of this starre aboue the earth.

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One line cutteth another squirewise, when they make right and equall angles.

The Contingent or touch line, is that which is drawne by any point of another line or circle, so that it toucheth the same: and this line commonly in all Dials is drawne squirewise to the Substile.

A quadrant is the fourth part of circle.

The Meridian and twelue a clocke line are all one.

I call these lines parallell, which are euery where of like distance one from another: example whereof you may see in the East and West diall, where all the houre lines be parallell.

You may make all kinds of plaine Dials vpon one stone, if you prepare it first to be square like a Dye, and then take off the eight corners, and all the sharpe sides, so shall you haue 25. plaine plats besides the base, or foote whereon your Diall must stand.

If any be desirous to haue this Instrument ready made, let him enquire at the Printers, and he shall heare of them.

**THE**



# The making of an Instrument to *finde out the situation of any plat or Diall, and to place them al- ready prepared.*

## CHAP. I.



As much as it is necessary be-  
fore you can draw any Dial, to  
know how your plat is already or  
ought afterward to be placed, it  
shall bee expedient to shew the  
making and vse of an Instrument  
whereby you may examine and  
try all plain plats, and place all  
dials being ready made and pre-  
pared.

Provide therefore an halfe circle of Pearetree, Walnut-  
tree, Box, or any other close grained and solid wood, being  
well seasoned, so that the alteration of the weather at any  
time may not make it change from the first proportion ther-  
of. Let it be perfectly tryed on both sides of an even thick-  
nesse, halfe or three quarters of an inch thick or more if you  
will, and sixe or eight inches broad as you thinke good. The  
edge or side A. B. must be very right. When draw the Line  
C. D. three quarters of an inch equally distant from the side  
A. B. place one foot of your compasses in the centre E. which  
is the midst of the line C. D. and with the other draw halfe a  
circle from C. to A. divide it into two equall parts or qua-



# The Art of Dialling.

quadrants, and laying your ruler vpon the centre E. and vpon this diuision draw the line E. F. this done, diuide each of these quadrants into 90. equall degrees of parts, which you may thus doe: First, diuide each of them into 3. equall parts, and euery of these into three other parts, so shall you haue 9 diuisions in either quadrant, whereof euery one shall represent ten degrees. Againe, part euery one of these into 2. and each of those into five (if you can) and so is each quadrant diuided into 90. degrees.

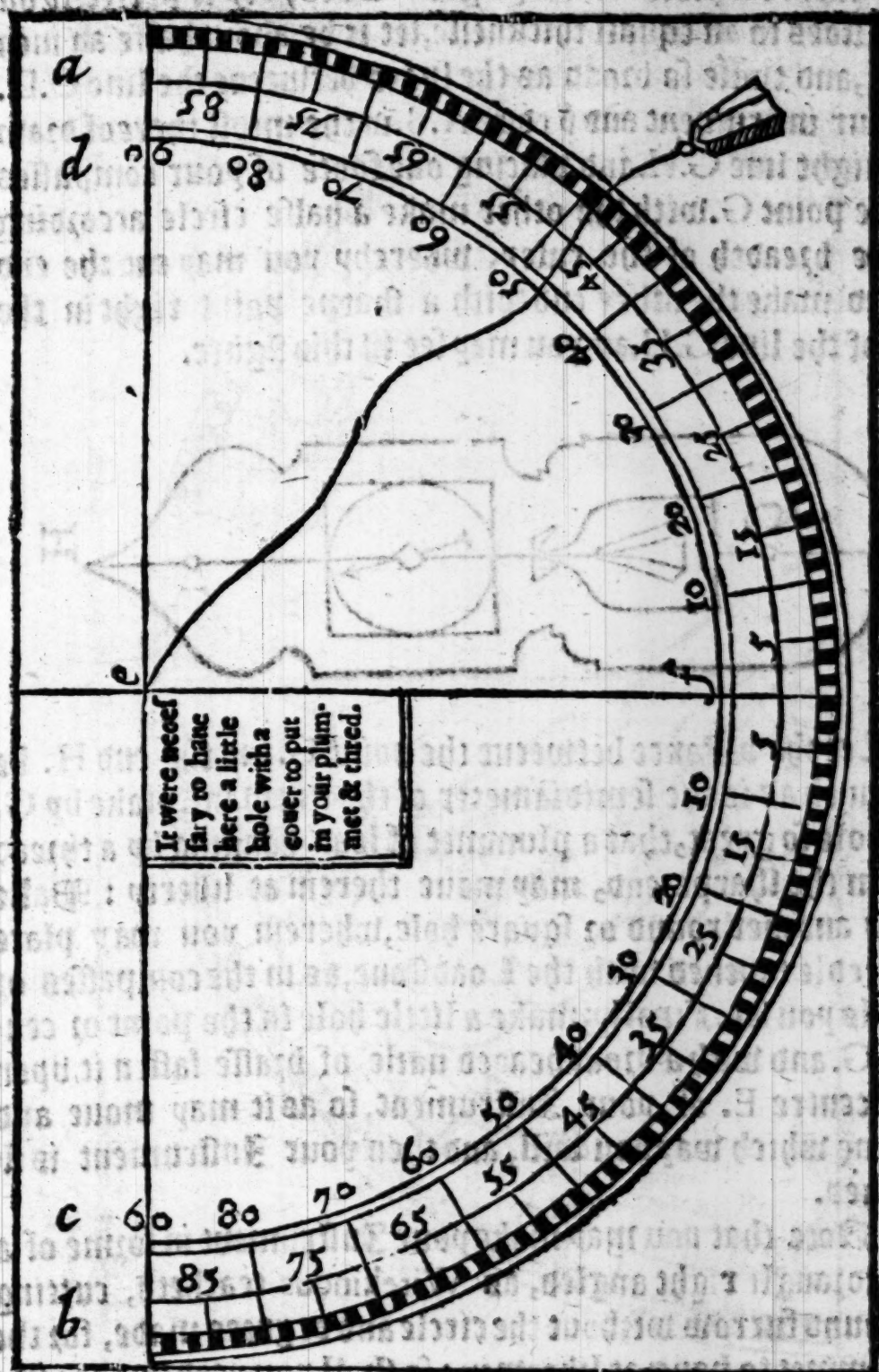
Moreouer, it were necessary if your Instrument were large enough, to part each degree into 60. minutes, or at the least into 3. whereof each part may containe 20. minutes. This done, fasten a thread well waxed, in the centre E. with a plummet of lead on the end, so that it may mooue at free liberty.

You may also (if you will) vpon this side of the quadrant between E. D. draw the diall, whose delineation is taught in the 28. Chapter.

The

# The Art of Dialling.

2

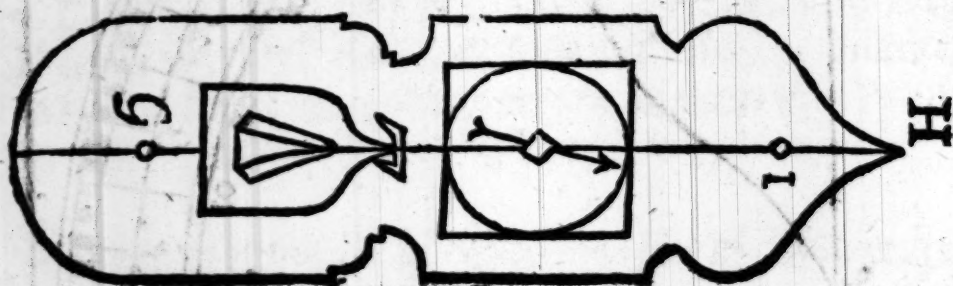


The former side of your Instrument thus finished, let the other be altogether like unto it, except that in stead of the thread with the plummet, you must have a plumbzule made in this manner.



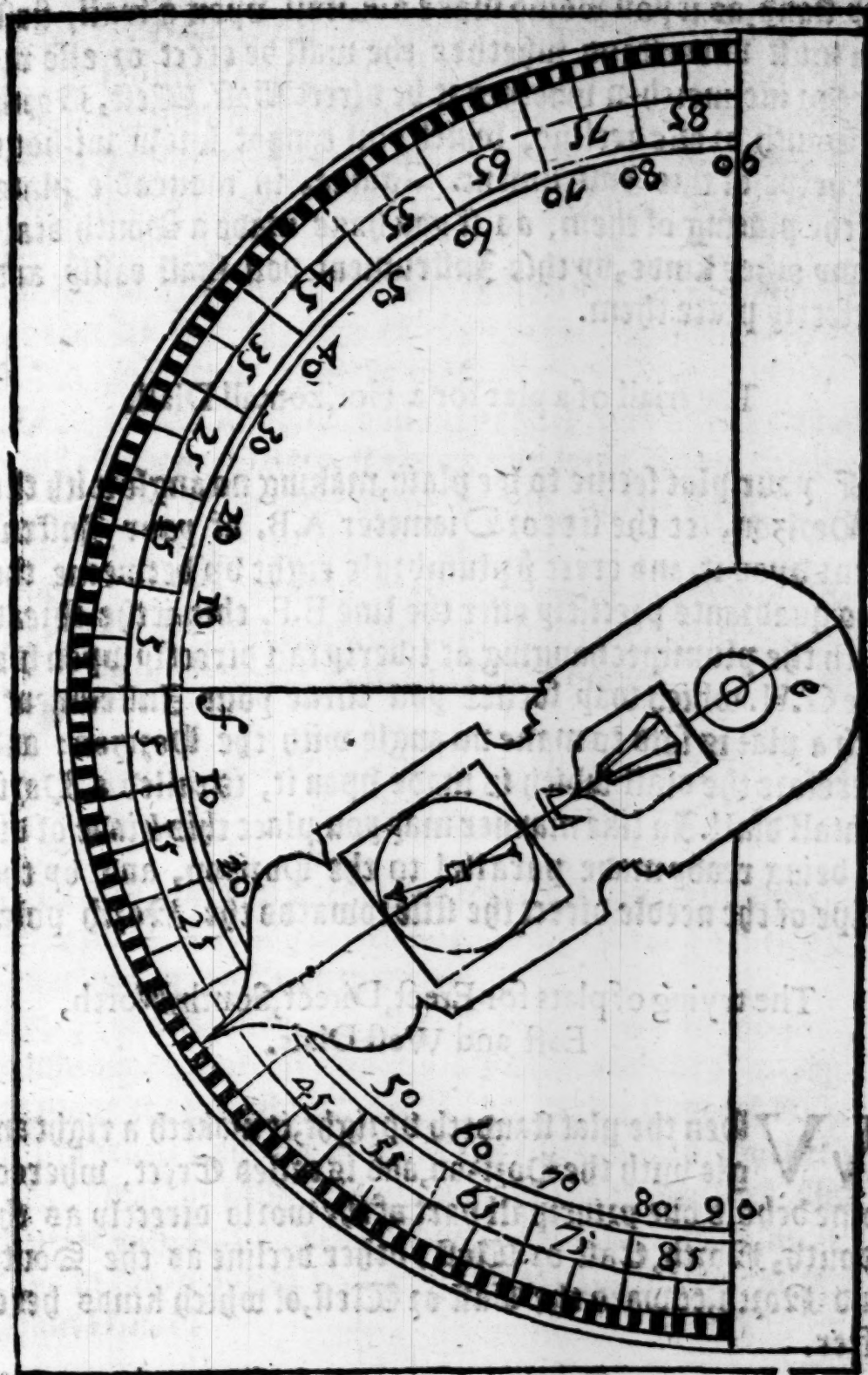
# The Art of Dialling.

Prepare a piece of very good wood, try it perfectly on both sides to an equall thicknesse, let it be about halfe an inch thick, and twice so broad as the space betweene the line C.D. of your instrument and the edge A.B. in the midst thereof draw the right line G.H. and placing one foote of your compasses in the point G. with the other make a halfe circle according to the breadth of the ruler, whereby you may cut the end round, make the other end with a sharpe point right in the end of the line G.H. as you may see in this figure.



Let the distance betweene the point G. and the end H. be so much as is the semidiameter of the quadrant, make by G. an hole so great, that a plummet of lead hanging by a thread from the sharpe end, may moue therein at liberty: Make also another round or square hole, wherein you may place a needle touched with the Loadstone, as in the compasses or dyals you see. Finally, make a little hole in the point or centre G. and with a broadheaded naile of brasse fasten it vpon the centre E. of your Instrument, so as it may moue and turne which way you will, and then your Instrument is finished.

Note that you may make your Instrument in forme of a quadrangle right angled, as Witkindus teacheth, cutting a round furrow without the circle and degrees made, for the plummet to hang at liberty in: so shall you need but one side of your instrument to be with a compass or needle touched with the Loadstone for the declinations. But the forme of the other, whose making we haue taught, seemeth more commodious, behold the figure.



## The vse of this Instrument. CHAP. 2.

**T**he vse of this instrument is in examining and placing the plat of diall. In immouable places, to know how they



# The Art of Dialling.

they stand, as if you would make a Diall vpon a wall, first you must vnderstand whether the wall be erect or else recline or incline: then whether it be direct East, West, North or South, or else decline, which you cannot know without the helpe of this Instrument. Againe, in moueable plats for the placing of them, as if you haue made a South diall or any other kinde, by this Instrument you shall easily and perfectly place them.

## The triall of a plat for a Horizontall Diall.

**I**f your plat seeme to lye plain, making no angle with the Horizon, let the side or Diameter A.B. of your Instrument vpon it, and erect y<sup>e</sup> plumbzule right vp betweene the two quadrants precisely ouer the line E.F. then if the thread with the plummet hanging at liberty fall directly vpon his line G.H. which way soeuer you turne your Instrument, such a plat is said to make no angle with the Horizon: and therefore the diall which is made vpon it, is called a Horizontall diall. In like manner may you place this kinde of diall being ready made parallel to the Horizon, and by the helpe of the needle direct the stile towards the North pole.

## The trying of plats for Erect, Direct, South, North, East and West Dials.

**V**hen the plat standeth vpright, it maketh a right angle with the Horizon, and is called Erect, whereof some behold one principall part of the worlde directly as the South, North, East, or West: other decline as the South and North, toward the East or West, of which kinds hereafter.

To examine an Erect plat, apply the side or diameter A.B. of your Instrument vnto it, the thread with the plummet on the fore side hanging at liberty. If the thread fall vpon the line E.C. or E.D. the plat is Erect.

This

# The Art of Dialling.

4

This done, apply the said line or diameter A.B. to the plat your Instrument being placed equally distant to the Horizon, and the plumbule upon the line E. I. then if the needle stand directly over his character, the end touched with the Loadstone being next to the plat, that plat is called a South Erect Direct.

In the North all the foresaid things are to be considered except onely that the end of the needle touched with the loadstone is farthest from the plat.

These things knowne, you may easily find out the East and West Erect Direct, if either you have a line drawne squarewise to the character of the needle, or else if you place the plumbule over the line E.C. or E.D.

And here note, that the East and West are not said to decline, because the declination is accounted from the south and North: to the direct East and West points.

## The examining of plats for Declining Dials,

**A**ll such plats as behold not some principall part of the world directly, are called Declining. The quantity of their declination is found out thus.

Apply the diameter A.B. of your Instrument to the plat, remembering to hold it equally distant from the Horizon. Then moue the plumbule untill the needle standeth right over the character, and the point of the ruler, which toucheth the degrees in the limb, shall shew how many degrees and minutes it doth decline: either toward the East if the plumbule lye in the quadrant C.E.F. or toward the west, if in the quadrant D.E.F.

## The trying of such Plats as recline.

**I**f the plat standeth not vpright, but maketh an obtuse or blunt angle with the Horizon, it is said to recline. The  
degrees



# The Art of Dialling.

degrees of the reclinacion are found out thus.

Apply the Diameter A.B. of your Instrument to the plat, the one end placed upward, the other downward: then moue the plumb rule (the thread with  $\text{h}$  plummet hauing free course vntill the thread hang precisely ouer the line G.H. then the point of the ruler shall shew the degrees of reclinacion.

How inclining plats are tryed.

**B**ut if the angle which the plat maketh with the Horizon be acute or sharpe, then it doth incline. The quantity of inclination is thus knowne.

Apply the Diameter A.B. of your instrument to the plat, the thread with the plummet of the former side hanging at liberty, and marke what degree and minute the thread shall cut, for so much is the inclination.

The manner of trying those plats which recline and decline, or incline and decline.

**I**f your plat shall both recline and decline, or incline and decline: First seeke out the reclinacion as hath been shewed, and then the declination as in Erect declining.

The making of a Horizontall, or plaine lying Sunne Diall.

CHAP. 3.

**O**ur plat being prepared smooth and plaine, draw vpon it two lines, as in the figure following, the one A.B. the other C.D. cutting themselves squarewise, that is, making right angles in the point E. vpon which make the quadrant of any circle from the line E.C. to the line E.A. or E.B. and write at C. the North, at D. the South, at A. the East, at B. the West. And the line C.A. which here is the quadrant being diuided into 90. degrees or parts, the elevation

tion of the Pole shall be accounted in it (which in our example is 52.<sup>d</sup> from C. to A. and at the end of this number draw a line from the centre E. which shall be E.F. representing the stile and Arrière of the world. Then draw another line K. L. by C. or by some other point of the line D.C. square-wise, so long as you can, which shall be called the touch line, or line of Contingence. Then measuring with your Compasses the least distance of the point O. and the line E.F. or the stile, the one foot placed in O. which is the point of intersection, and the other extended toward E. where it shall chance to divide or be placed in the line E.C. marke that point or centre with the letter G. and draw with your Compasses a halfe circle upon this centre for the Equinoctiall circle, from H. by C. to I. whose Diameter must be equally distant to the line L. K. Then divide this halfe circle into 12 equall parts: this done, lay a Ruler upon the centre G. and upon euery marke or diuision made in the halfe Equator, and where the Ruler shall touch the line of Contingence, there make markes or prickes, by which prickes draw lines from E for the houres. E. C. is the 12 houre. E. B. the 6 in the morning. E. A. the 6 at euening, the rest you may see in the Figure

And whereas in Summer the 4 and 5 in the morning, and also the 7 and 8 at euening, shall bee necessary in this kinde of Diall: prolong or draw the lines of 4 and 5 at euening, beyond the centre E. which shall shew the houres of 4 and 5 in the morning. And likewise the 7 and 8 in the morning, for the 7 and eight at euening.

You may obserue an order both in these and in all other erect direct Dials, by diuiding the one halfe of the Equator, drawing houre lines for the forenoone, and obseruing the same distance from the Meridian line, on the other side for the afternoone: for the line of the 11 houre in the forenoone, is of like distance from the Meridian, that the 1 is in the afternoone, and the 10 as 2 and so of the rest.

When you would draw or make the halfe houres, you must diuide euery part of the Equator into 2 equall parts, using the Ruler and the line of Contingence as you finde in the



# The Art of Dialling.

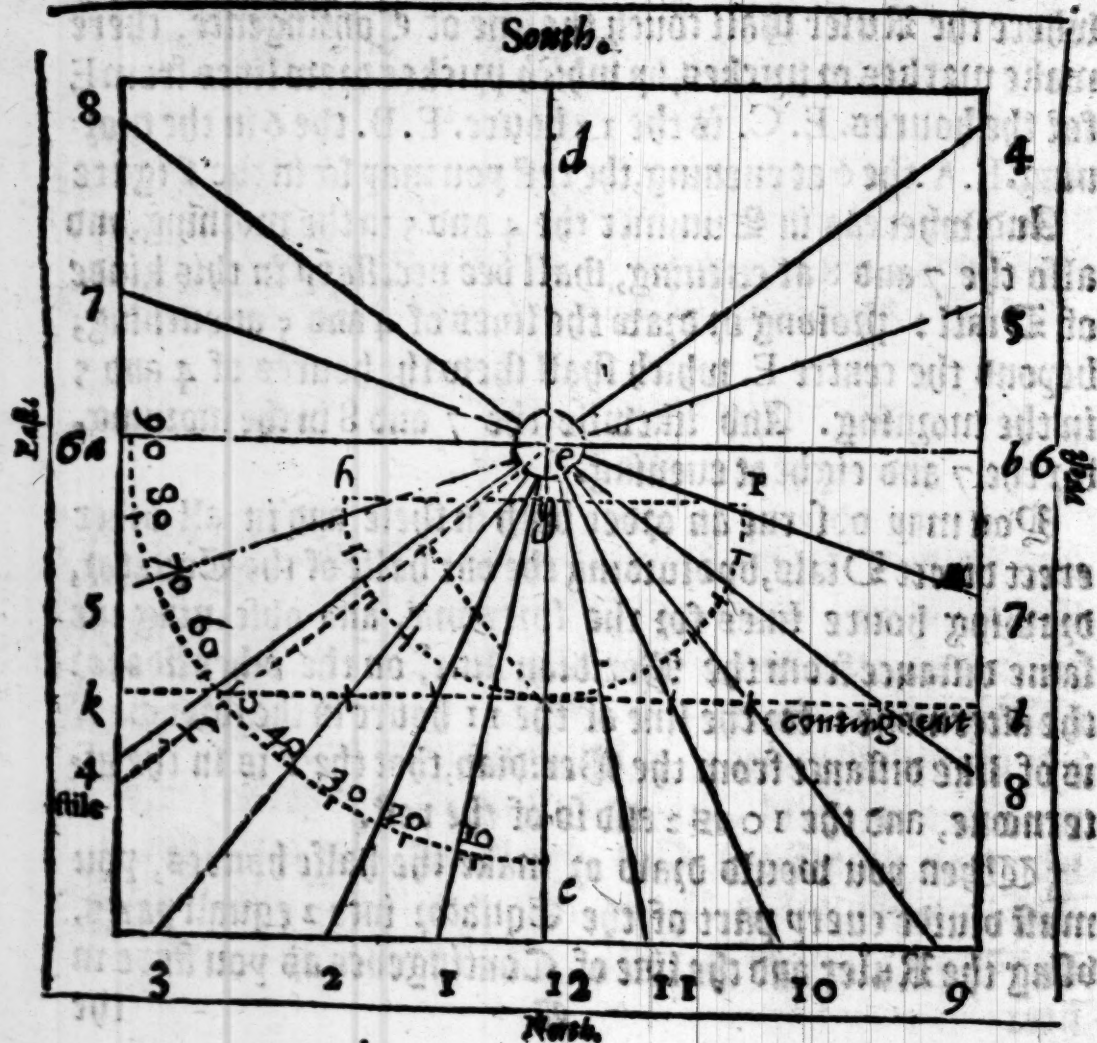
the drawing of the house lines.

And this remember for the drawing of the halfe houre.  
lines, not onely in this kinde, but also in all other kindes of  
dials, which afterward shall follow.

The Style must be fixed in the centre E. hanging directly over the Meridian line E.C. with so great an angle, as the lines C.E.F. make, declining from that on neither sides.

The Equinoctiall circle, the Quadrant, the line of the stile and of Contingence, must be lightly drawne, because they ought to be put out againe, in that they serue to no vse but for the drawing of the Diall. And this likewise remember in all other kindes of Dials, that the preparatiue or pricked lines must, after the making of the Diall, be omitted and extinguished, as altogether vnprofitable.

This and all other kindes of Dials may most fitly bee drawne vpon a cleane paper, and then with the helpe of your compasses placed on the plat.



The making of a South erect, direct Diall.

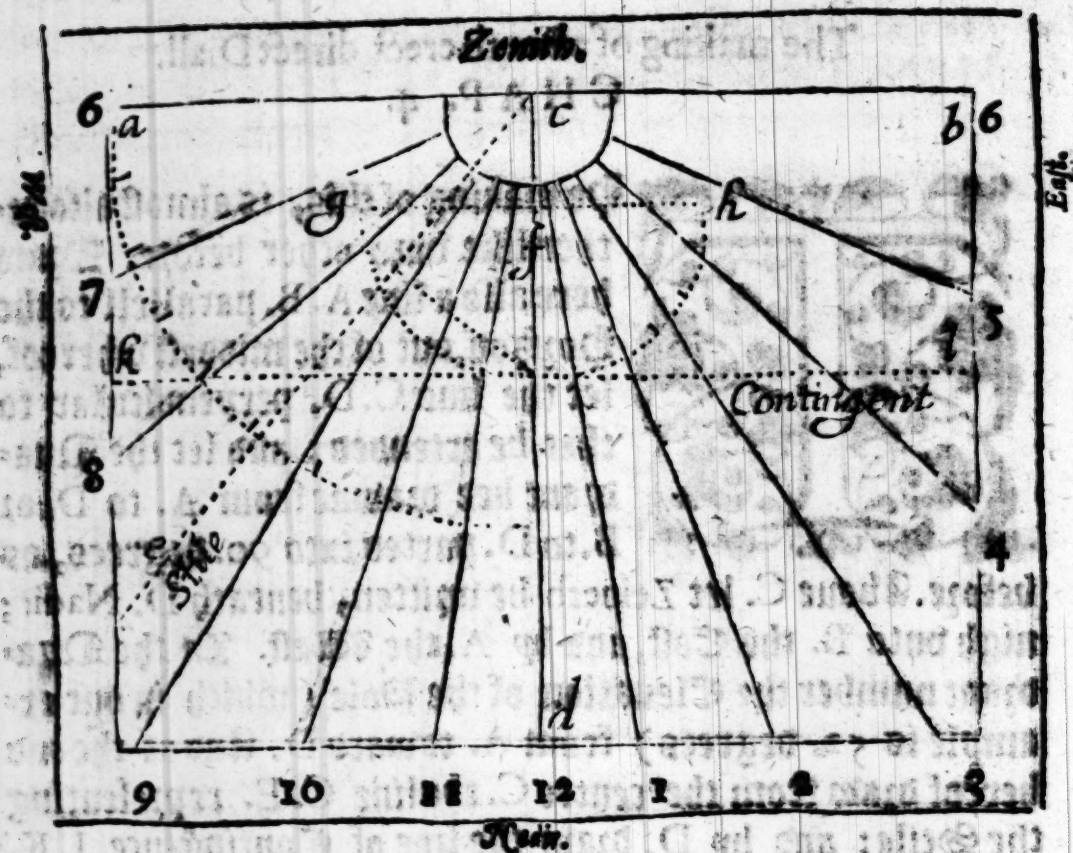
CHAP. 4.



**D**he making of this, is almost altogether like unto other before. Draw here also a line A. B. parallel to the Horizon, out of the midst whereof, let the line C. D. perpendicular to that be extended: and let the Quadrant bee drawne from A. to D. or B. to D. parted into 90. degrees, as before. Above C. let Zeinech be written, beneath D. Nadir; nigh unto B. the East, and by A. the West. In the Quadrant number the Elevation of the Pole (which in our example is 52. degrees) from A. toward D. And at the end hereof draw from the centre C. the line C. E. representing the Style: and by D. draw the line of Contingence, I. K. squirewise, as before. Then the least distance of the point of intersection D. and the Style being taken with your Compasses, extend them in the line D. C. the one foot placed in D. set the other in F. toward C. and draw by F. the Diameter of the halfe circle of the Equator equally distant to the line K. L. which must be made upon the centre F. from G. by D. to H, and divide it into 12. equall parts, upon every one of which and the centre F. the ruler being placed, where-soever it shall happen to touch the line of contingence, there make markes. Then from the centre C. by these markes the houre line must be drawne. The line C. A. shall shew the 6. in the morning, C. B. the 6. at evening, C. D. the 12. or. The Style must be placed or fixed in the centre C. hanging precisely over the line of the 12. houre, with so great a distance, as the angle D. C. E. is. This kinde of Diall both receiveth and sheweth only but 12. houres at the most.



# The Art of Dialling.



The making of a North Erect, Direct Diall.

CHAP. 5.



Here as in the South make a line  
 Parallell to the Horizon, A. B.  
 put it square-wise with the Per-  
 pendicular C. D. let C. be the  
 centre. At C. write Zedich, at D.  
 Nadir, &c. From C. draw the  
 Quadrant of a circle to D. or B.  
 divide this into 90. Degrees,  
 account the Elevation of the  
 Pole (which in our example is 52. d.) from A. toward C.  
 Draw at the end of this number the line E. F. for the Stile.  
 Afterward draw the line of Contingence by C. square-wise,  
 and take the shortest distance, with your Compasses between  
 the point C. and the Stile, placing the one foote in the point  
 C.

# The Art of Dialling.

5

C. extend the other toward E. in the line C. D. : making a point or picke G. : whereupon (as a centre) the same wide-  
nesse of the Compasses remaining, describe the halfe Equa-  
tor by C. ended with the Diameter .H. I. equidistant to the  
line of the contingence. When you haue diuided this halfe  
circle of the Equator into twelue equal parts, lay the ruler  
vpon the centre G. and vpon each diuision of the Equator  
and where it shall touch the Contingent line, make markes.  
This done, draw the lines for the houres, by those markes  
from the centre E. but those very few, that is, two nigh vnto  
A. and two by B. but prolong and extend them beyond the  
centre E. so that their contraries may be made : for in this  
kinde of Dialls there be but onely tenne houres profitable,  
that is, 4, 5, 6, 7, 8, before noone, and 4, 5, 6, 7, 8. after noone ;  
which shew but onely in Summer, from the entring of the  
Sunne into  $\gamma$ , vntill such time as it entreteth  $\alpha$ .

The stile must be fixed in the centre E. placed vppward,  
directly ouer the line E. C. with so great an angle as I. E.  
C. is. Let the line C. D. bee placed vppward perpendicularly,  
but so, that it may not be almost seene, as afterward seruing  
to no vse, because it is onely a line preparatiue.

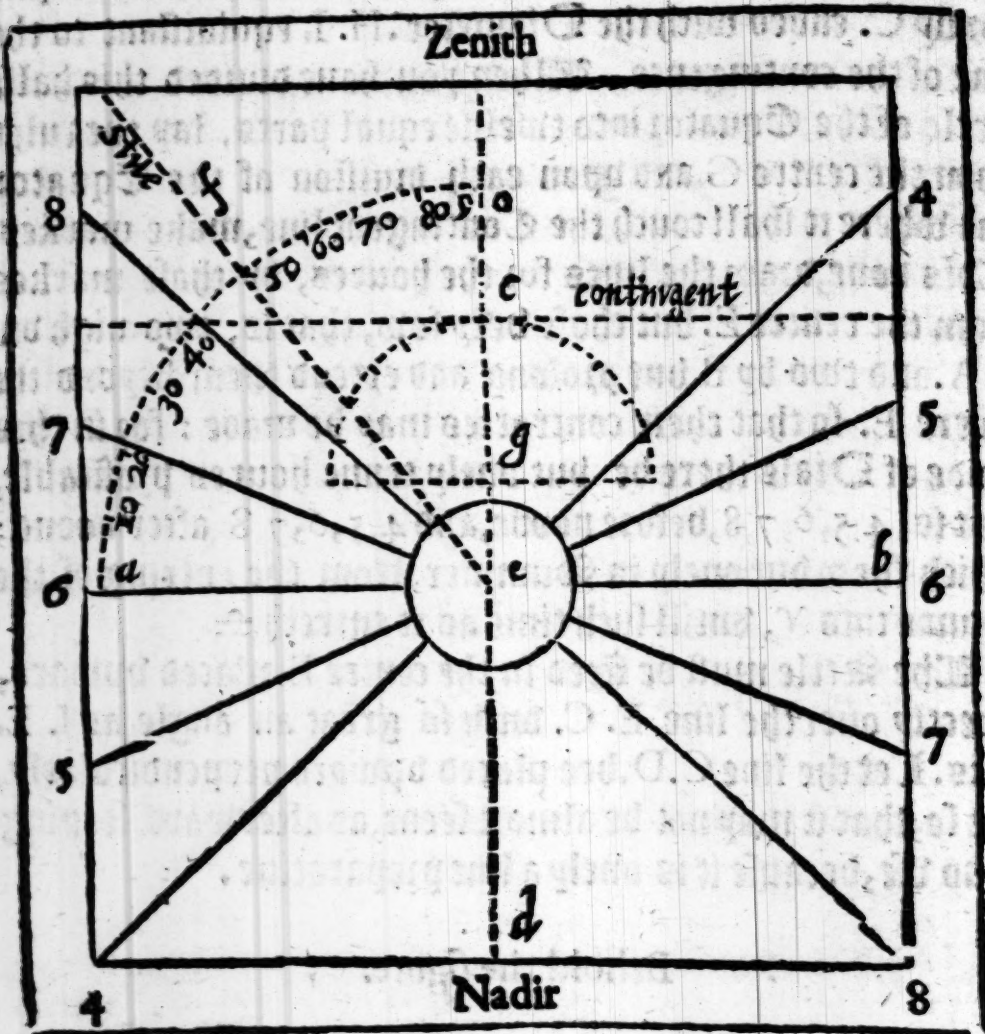
Behold the figure.

A North



# The Art of Dialling.

**A North Dial erect, direct.**



## The making of the East and West Erect Dials.

## СНАР. 6.



If you know the making of one of these, you may easily make them both, for they be very like, differing onely in the naming of the houres, for the one containeth houres for the forenoone, and the other for the afternoone.

You must therefore on your plat make the quadrant of a circle A.B.C. which may afterward easily be put out, as all

all the other lines must bee, except the houre lines: let the A.B. be Perpendicular: B.C. Parallel to the Horizon, and let the arke behold the South, which being deuised into 90. degrees, number therein the eleuation of the Pole downward from A. toward C. by the end of this number, and by the Centre B. draw a line so long as your plat will giue you leaue, whose South end shall behold precisely the Equinoctiall circle. At which end draw a circle, whose diameter shall be almost the third part of the line. Then draw another Diameter or line in the centre, squarewise to the other, which shall shew the arctree of the world, and be the line for the 6. houre. Afterward at the outwardsides of the circle, draw two contingent lines, one beneath, the other aboue, so that they may be Parallel to the middle line. Diuide each quarter of the circle in sixe equall parts. Then place the ruler vpon the centre, and each of those markes or parts, and where it toucheth the lines of contingence, there make markes in them. Afterward draw a line by those two markes which bee next to the 6. houre, in the lines of contingence, which may be equally distant from the line of the 6. houre.

In like manner doe with the rest; so that you may haue in the East Diall, two aboue the 6. houre, the 4. and 5. in the morning, and vnder it 7, 8, 9, 10, 11. In the West Diall likewise 7. and 8. in the euening about the 6. houre, and vnder it 6, 5, 4, 3, 2, 1. Neither of them doe shew the 12. houre, because at that time the Sunne beames be parallel to the plat.

Fixe the Style in the centre of the circle right vp from the Plat, so long as the Semidiameter of the circle is onely shewing the houre with the very top or end thereof. Yet it were more conuenient to haue it placed along ouer the line of the 6. houre, being a plate of yron or some other metall, being so broad as the Semidiameter of the circle is.

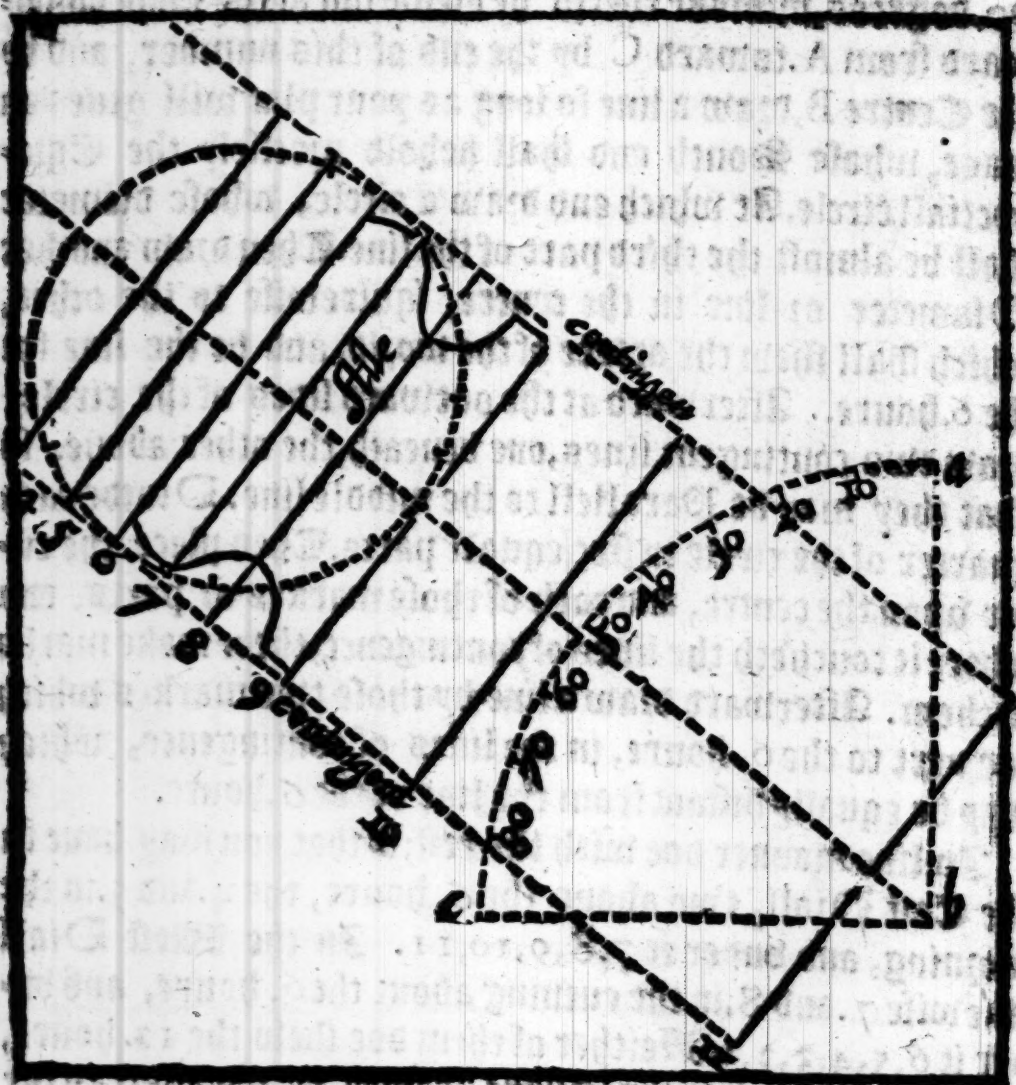
Behold the figures following.

The



# The Art of Dialling.

## An East Dial Erect.



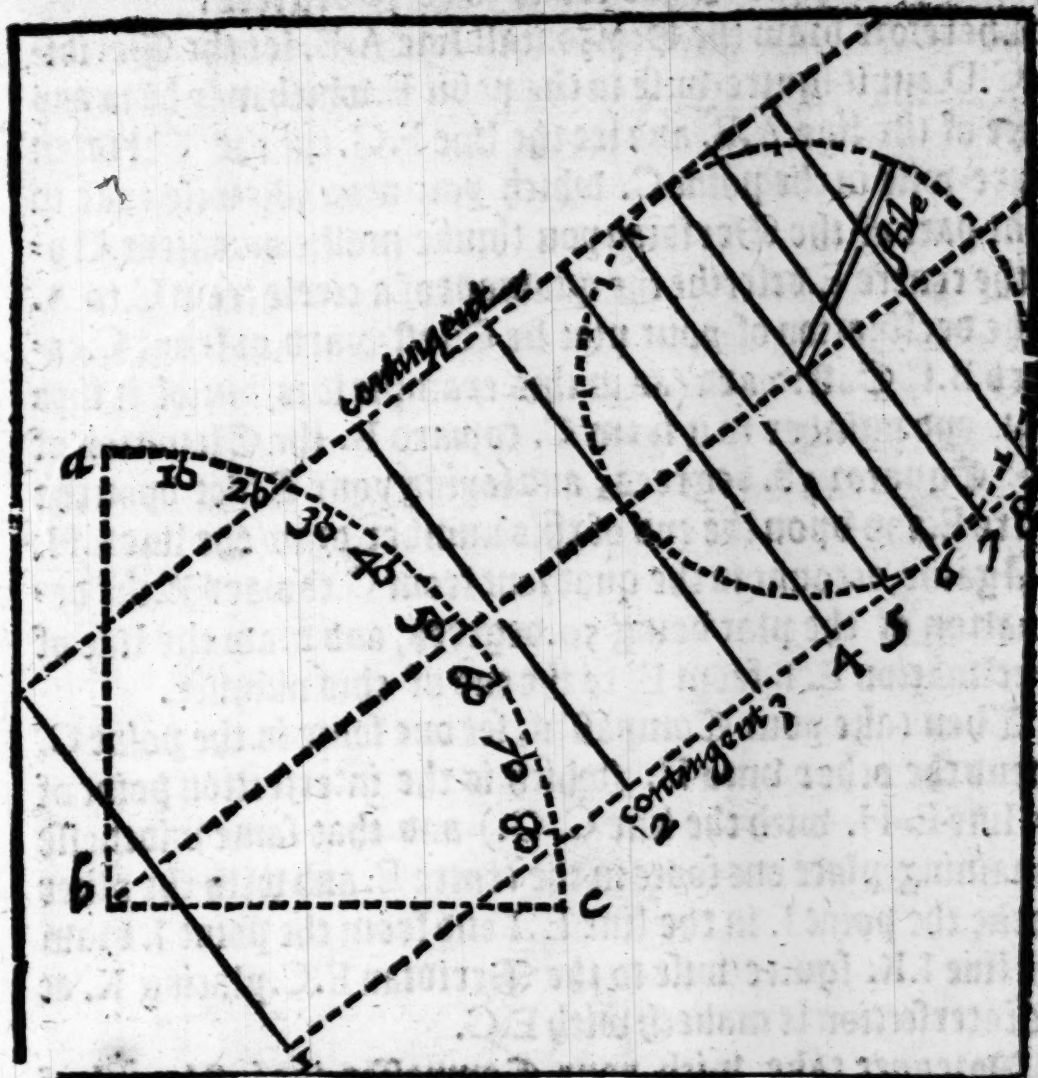
Behold the figures following.

The

# The Art of Dialling.

9

The West Dial erect.



Note that these five kindes of Dials before taught may be made vpon a stone cut square in the forme of a die.

The making of a South Erect declining Diall, which may be placed on any vpright wall what-  
focuer.

## CHAP. 7.

**I**n all Declining Dials because the Stile doth not hang directly ouer the Meridian line, therefore you must first finde out and place the Sub-  
stile (which is the line ouer which the Stile di-  
rectly haugeth) and likewise the line of the Stile: which may be both easily and speedily performed in this manner.

First, by your Instrument seeke out the Declination of  
D the



# The Art of Dialling.

the wall or plat, whereupon you would make a Dial, which for example suppose I had found to be 50 degrees.

Therefore draw the Horizontall line A.B. let the Meridian C.D. cut it squire-wise in the point E. which may be in any place of the line A.B. and let the line F.G. cut the Meridian squire-wise in the point C. which you may likewise take in what part of the Meridian you thinke most convenient. Upon the centre E. describe the quadrant of a circle from C. to A. if the declination of your plat be Westward, or from C. toward B. i. Eastward (as in this example it is) divide it into 90. d. and number in it from C. toward B. the Elevation of the Equator 38. degrees, and laying your Ruler upon the centre E. and upon the end of this number, draw the line E.H.

\* This is al-  
ways so much  
as the Elevati-  
on of the Pole  
wanteth of 90  
degrees.

Againe, account in the quadrant from C. toward B. the declination of the plat being 50. degrees, and draw the line of Declination E. I. from E. to the end of this number.

Then take your Compasses, set one foote in the point C. extend the other unto H. (which is the intersection point of the line E. H. with the line C. G.) and that same widenesse remaining, place one foote in the centre E. and with the other marke the point I. in the line E. I. and from the point I. draw the line I.K. squire-wise to the Meridian E.C. placing K. at the intersection it maketh with E.C.

Moreover take with your Compasses the iust length of the line I. K. and placing one foote in C. turne the other toward F. and make the point L. in the line C. F. draw the Substile from E. by L. Let the line of Contingence be drawne squire-wise to the Substile in the point L.

This done, take the distance betwene the centre E. and the point K. and place it in this line of Contingence from the point L. unto M. and make the point M. that the line E. M. may be made from E. unto M. for the Stile.

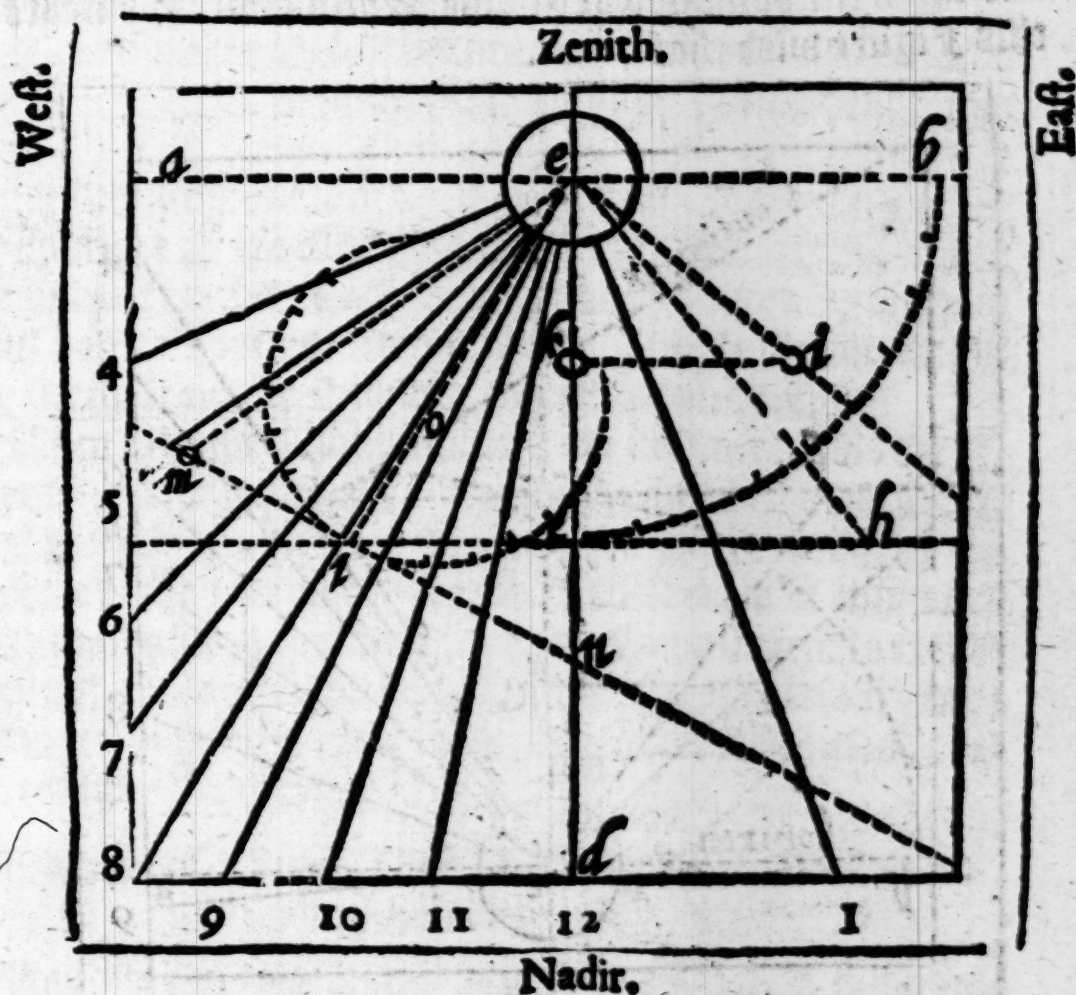
Measure with your Compasses the least distance betwene the point L. and the Stile, and with the same widenesse, one foote remaining in L. turne the other toward E. and make the centre O. in the Substile: upon which describe the Equinoctiall.

# The Art of Dialling. 10

noctall circle. Then placing your Ruler vpon O. being the centre of the Equinoctial circle, and N. (which is the point of the intersection of the Meridian and Contingent) marking where it cutteth the circumference: for there you must begin to divide it into 24 equall parts, notwithstanding those 12 are onely in vse which are next the Contingent.

Finally, place your Ruler vpon the centre O. and vpon the severall division points of the Equator, and where it toucheth the line of Contingence, make markes, by which from the centre E. draw the houre lines.

Place the Meridian perpendicularly vpon the wall, the centre E. upward, the Stile pointing downward. Let the Stile hang directly over the Substile making an angle equall to E. M. L.





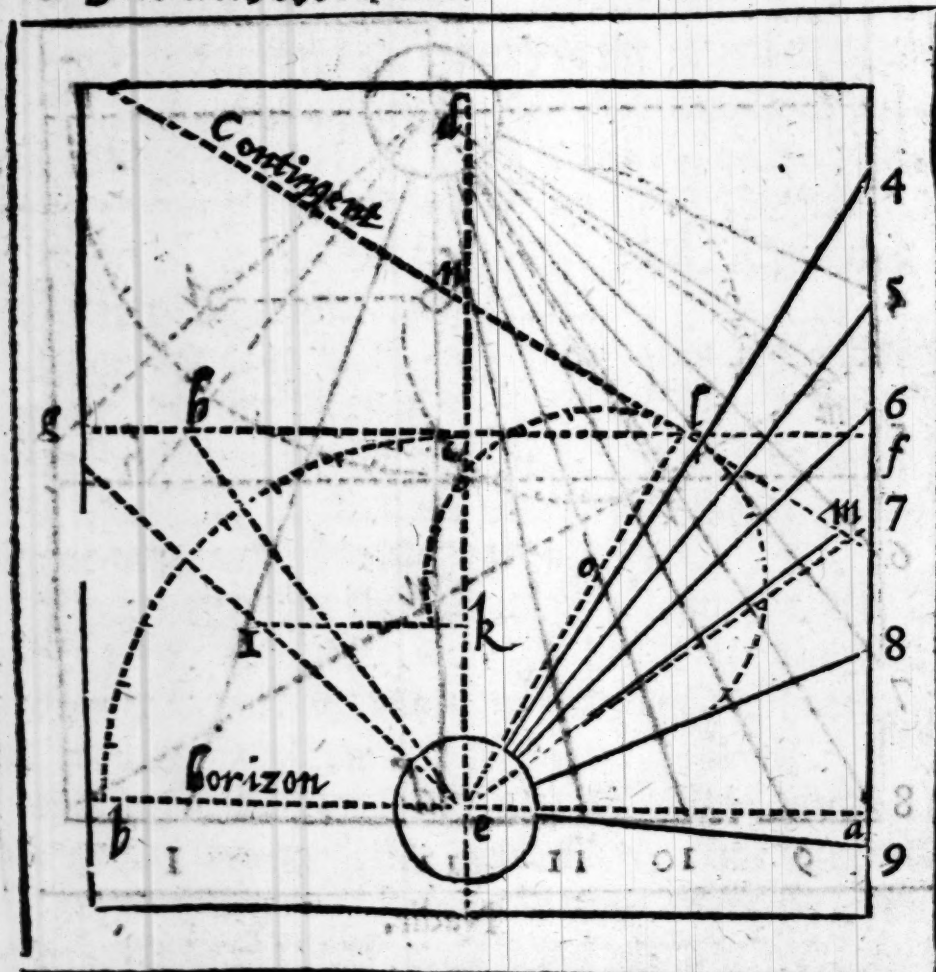
# The Art of Dialling.

The making of a North Erect Declining  
Diall. CHAP. 8.

**T**he North Erect Declining Diall differeth from the South onely herein, that the centre is to bee placed downward, the Stile pointing upward to the North Pole, and that the Meridian representeth the 12 houre at midnight and at noone. Therefore if the Declination be toward the East, you must account the houre lines, from that which is as it were the Meridian forthward, 1, 2, 3, 4, 5, 6, &c.

But if it decline toward the West, number them backward, 11, 10, 9, 8, &c. omitting the first 3 which are before Sunne rising and after Sunne setting in our Elevation.

Let the line E.D. be placed perpendicularly vpon the plat, and the Stile point vpward to the North Pole. Compare this Figure with the former.



Another

## Another way to make a South Erect Declining Diall.

### CHAP. 9.



Albeit wee haue plainly and perfectly shewed the making of the South and North Erect Declining Dials, in the two former Chapters; yet to satisfie them that delight in variety; here is also declared another way, whereby you may make them, namely, by the helpe of

Reade the vse of the Table of Sines.

Arithmeticke, and the Table of Sines which is placed in the end of this booke for this intent.

Therefore the Elevation of the Pole being knowne, and the Declination of your plat, by your Instrument found out:

Multiply the Sine of the Complement of the Elevation, by the Sine of the Complement of the Declination, diuide the product by the whole Sine (which is 100000) and you shall haue a quotient Sine, whose Arche is the distance of the stile from the Substile, which distance keepe.

Then take the Complement of this distance, and the Elevation of the Pole, and multiply the Sine of the lesser by the whole Sine, parting the product by the Sine of the greater: the quotient Sine which shall come of this diuision, shall giue you an Arche, whose Complement is the distance of the line of the Substile from the Meridian, which distance you shall likewise keepe. For better instruction herein, consider the Example.

Example of a South Diall Declining 45. d. Elevation of the Pole 52. d.

I first, I enter the Table of Sines, for the Sine of the Complement of the Elevation, which is 38. d. and I find



# The Art of Dialling.

it to be 61566. Then I looke for the Sine of the Complement of the Declination, which is  $45^{\circ}$ . and I finde that to be 70710. This done, I multiply the one by the other, and the product is 435331860. which I divide by the whole Sine being 100000. whereof commeth a quotient 43533. With this quotient Sine I enter the Table, and because I finde not the iust number, I take that which is next either greater or lesse vnto it: (which you must alwayes remember to doe) for so small a difference maketh no alteration, and therefore I take in stead thereof  $43523$ . whole Arke is  $25^{\circ}$ .  $48'$ .  $3''$ . which is the distance of the Stile from the Substile.

Then I take the Complement of this distance, which is  $64^{\circ}$ .  $12'$ . whole Sine is 90031. and the Elevation of the Pole  $52^{\circ}$ . whole Sine is 78801. and multiplying the Sine of the lesser, (which is the Elevation of the Pole) by the whole, 100000. the product is 7880100000. which I divide by the Sine of the greater, to wit, the Sine of the Complement of the distance of the Stile from the Substile, whose Sine is 90031, whereof commeth this Quotient 87526 whole Arke is  $61^{\circ}$ .  $5'$ .  $3''$ . The Complement of which Arke is  $28^{\circ}$ .  $55'$ . being the distance of the Substile from the Meridian. These distances being thus found out, the drawing of the Dial followeth.

First, draw a line Parallel to the Horizon A. B. out of whose middle point C. draw the Meridian line square-wise C. D. upon the centre C. make the Quadrant of a circle betwene A. and D. Here vnderstand that generally in all kindes of declining Dials, if the declination be towards the East, you must draw the Quadrant towards the West, (except in the South reclining declining, and the North inclining declining, where the Contrary is prescribed.) But if the declination be Westward, the Quadrant must be drawne Eastward. Hereby you shall easily know on which side you ought alwayes to draw the Quadrant, and which way the figures following doe decline. Your Quadrant being made, divide it into 90 degrees: number therein from D. the

the distance of the Substile from the Meridian, which is 28.<sup>d</sup>. 55.<sup>m</sup>. Draw at the end of this number the line C. E. for the Substile. Then from E. towards A. account the distance of the Stile from the Substile, which is 25.<sup>d</sup>. 48.<sup>m</sup>. and at the end hereof, draw the line C. F. for the Stile. Afterward by the point E. or in any place of the Substile draw the Contingent line G. H. so long as you can squire: wile to the Substile. Then take with your Compasses the least distance between E. and the Stile, the one foot remaining in E. and the other extended in the Substile toward C. place at the picke there made with the Compasses, I. upon which picke as a centre, the same wideness of your Compasses remaining, draw a circle by E. which shall represent the Equinoctiall or Equator. Then lay the Ruler upon the point I. and the intersection (whose marke is K.) of the line of Contingence, and the line C. D. (which is alwayes drawne so that it may cut the other) and where the Ruler so placed shall touch the circle, there make a marke, and there begin to divide it into 24. equall parts: notwithstanding those 12 onely are to bee used, which doe behold the Contingent line. Then lay the Ruler upon the centre I. and the Contingent line by every division of the Equator, and where it shall touch the line of Contingence, there make markes, by the which from the centre C. draw lines for the houres, so many as shall be necessary.

The line C. D. shall alwayes shew the 12 houre, which must hang perpendicularly. Number the residue of the lines in their place, as they follow in order.

The line A. B. in such as doe decline is unprofitable, except it so chance that some houre line falleth in it.

Let the Stile bee fixed in C. hanging directly over the Substile, with so great an angle, as E. C. F. is, declining on neither side.

Note diligently the making of this declining Diall, because in those which follow, wee meane not to repeate those things which here haue bene taught. And this one kinde

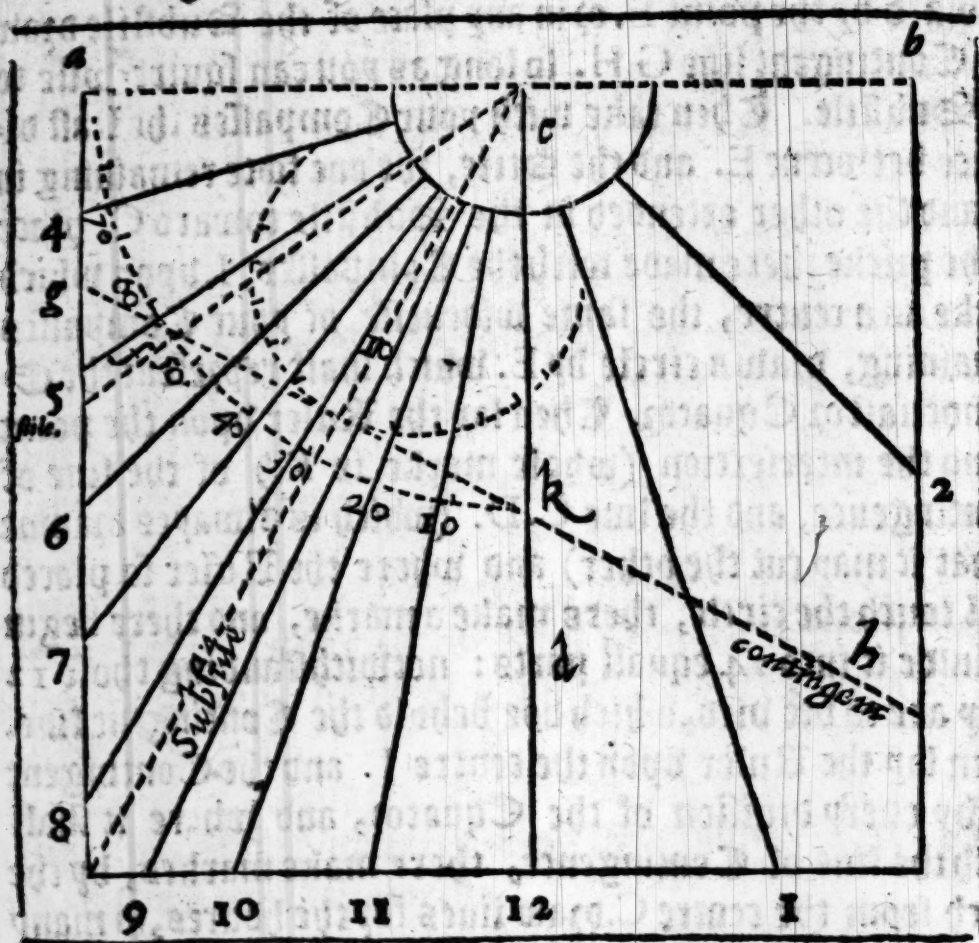
well.



# The Art of Dialling.

well knowne, all the other will seeme most easie. For better understanding hereof, behold the Figure.

A South Erect declining Diall.



The making of a North Erect declining Diall  
another way.

## CHAP. 10.



The distance of the stile from the Substile, and of the Substile from the Meridian, is found out altogether like to the South Erect declining. Therefore you may resort thither for the working hereof, I will onely draw the Figure.

Let

Let the line A. B. being parallel to the Horizon, cut C. D. squarewise, placing E. at the intersection. Draw the quadrant from C. to B. divide it into 90. d. accounting therein from C. toward B. the distance of the Substile from the line, which is (as it were) the Meridian, which distance is 28. d. 55. m. At the end of this number draw the line E. F. for the Substile. Then number from that line the distance of the Substile and the Stile, which is 25. d. 48. m. towards B. Draw likewise at the end of this number the line for the Stile E. G. This done, let the line of Contingence be drawn squarewise by the point F. and then taking the least distance between the point F. and the Stile, extend the compasses in the line F. E. the one foote being placed in F. where the other shall divide the line, place the letter H. With the same wideness of the compasses draw upon the centre H. the Equator, and where the ruler shall touch the same being laid upon the centre H. and the intersection of the Contingent line, and that which is (as it were) the Meridian, begin to divide it into 24. equall parts. Finish all things remaining, as in the South erect declining, onely this excepted, the Stile being fixed in the centre E. must be placed upward, beholding the Substile with so great a distance or angle, as the letters F. E. G. doe shew. The line C. D. being applied to the plat perpendicularly, sheweth as it were the 12. houre at midnight: therefore account from that the houre lines, as they follow in order, 1, 2, 3. which houres haue no vse in this kinde of Diall for our Elevation, but from 4, &c.

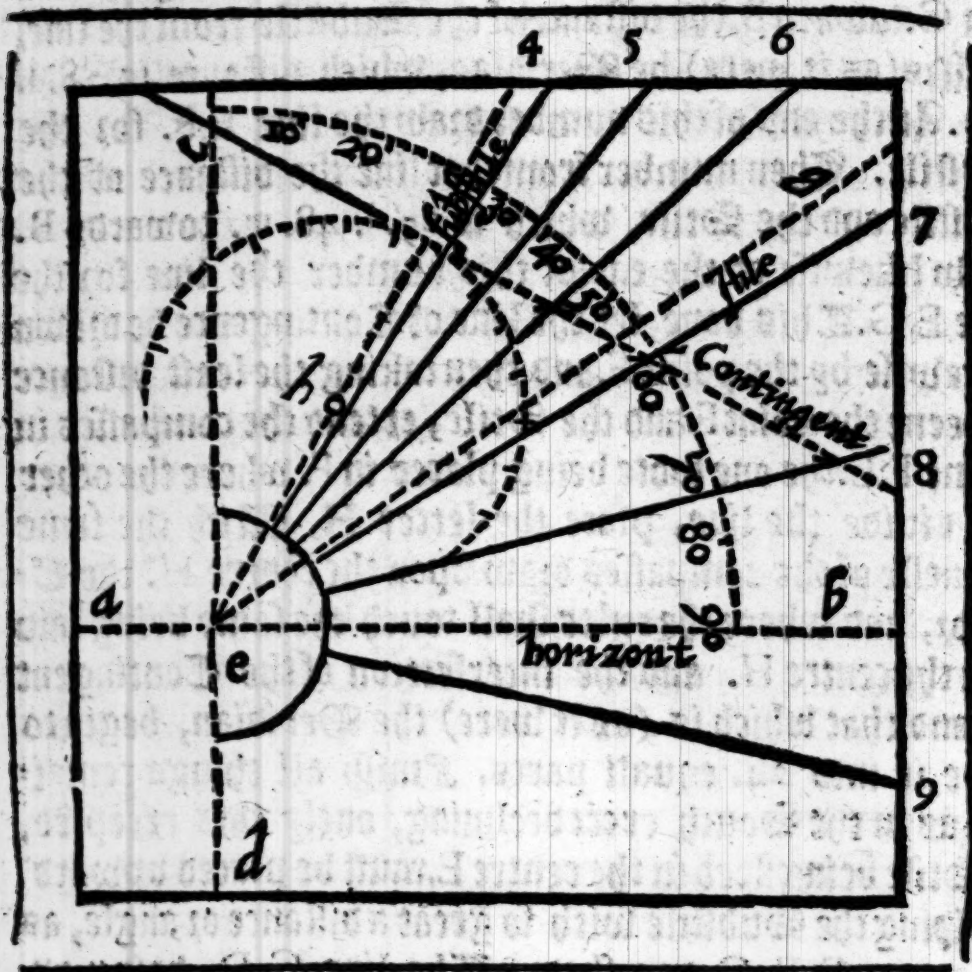
Let the line A. B. be parallel to the Horizon, being lightly drawne, as the other preparatiue lines be, seruing afterward to no vse,

Note, if the plat decline toward the East, as this figure doth, it is for the forenoon: and you must account the houre lines from that which is (as it were) the Meridian, forward 4, 5, 6, &c. If it decline toward the West, account them backward 11, 10, 9, as we shewed before.



# The Art of Dialling.


### A North erect declining Diall.



## The making of a Meridionall or South Reclining direct Dial.

## CHAP. II.



 If the Reclination of the plat bee lesse then the complement of the Elevation of the Pole, adde this complement, and the Reclination of the plat together, and with this number, as if it were the Elevation of the Pole, make a South erect direct diall and it will be perfect and fit for your plat.

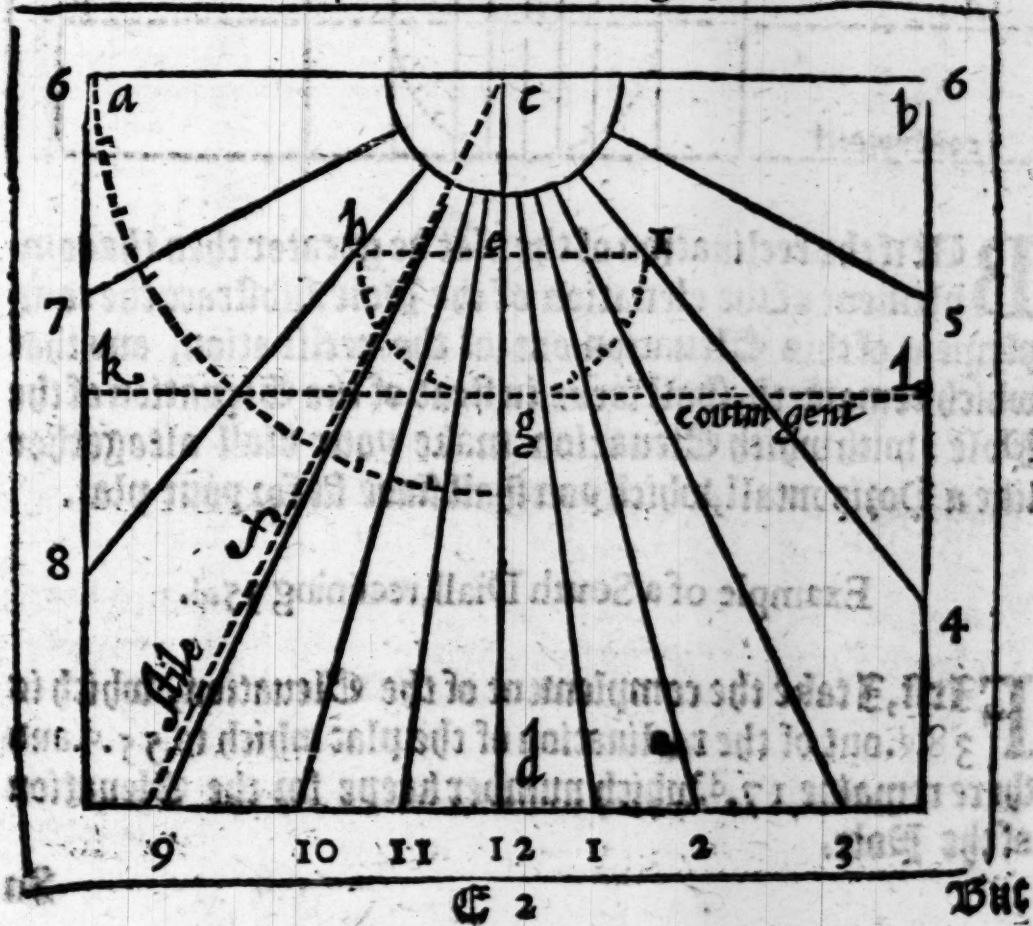
### Example

14

reclining 25°.

**M**ake the first line A. B. draw also another C. D. cutting the other with right angles. Then adde  $\frac{1}{2}$  Complement of the elevation of the Pole (which is  $25^{\circ}$ . to the re-  
clination of the place (which is  $38^{\circ}$ .) and the totall summe shall be  $63^{\circ}$ . which number being in place of the Elevation of the Pole, account it in the Quadrant from A. towards D. and at the end here of, draw the line F. for the stile. Then make the line of Contingence K. L. squirowise to the line C. D. Afterward take the least distance with your compasses betweene the point G. and the stile, with the widenesse, the one foote extended toward C. make a point or prick E. by which point draw the line H. I. equidistant from A. B. or K. L. upon E. make a halfcircle from H. by G. to I. which being divided into 12. parts, finish the rest as the South erect direct.

**A South Direct reclining 25.d.**



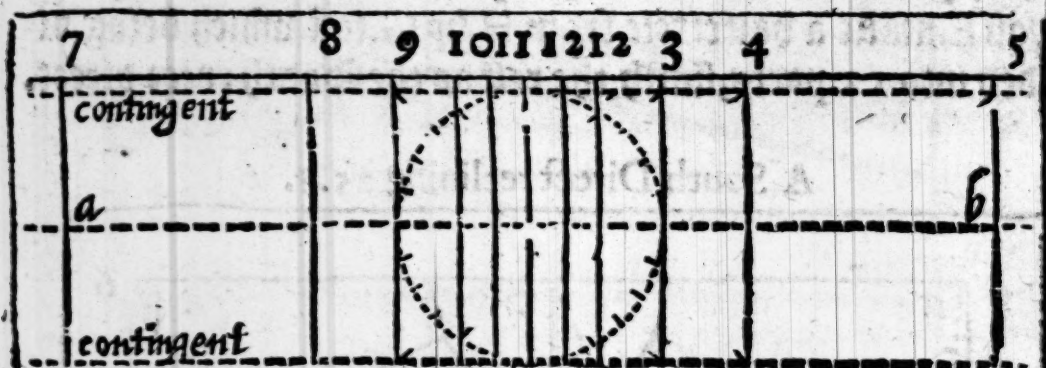


# The Art of Dialling.

**B**ut if the Reclination be equall to the complement of the Pole, make your Diall on this manner, like to the East and West.

Draw a line Parallel to the Horizon A.B. so long as the plat will give you leaue, diuide it into 7. equall parts, and with the same wideness of the compasses, in the midst of the line, make a circle representing the Equator. Then draw two lines of Contingence by the circumference of the circle, equidistant from the first A.B. Diuide the Equator into 24. equall parts. Finish the rest like the East or West diall: except in naming the houres, for that which is in them the 6. houre line, is here the 12, &c.

A South Direct reclining. 38.d.



**B**ut if the reclination of the plat be greater then the complement of the elevation of the Pole, subtract the complement of this Elevation out of the reclination, and that which remaineth, shall serue in stead of the Elevation of the Pole: with which Elevation make your diall altogether like a Horizontall, which you shall finde fit for your plat.

Example of a South Diall, reclining 55.d.

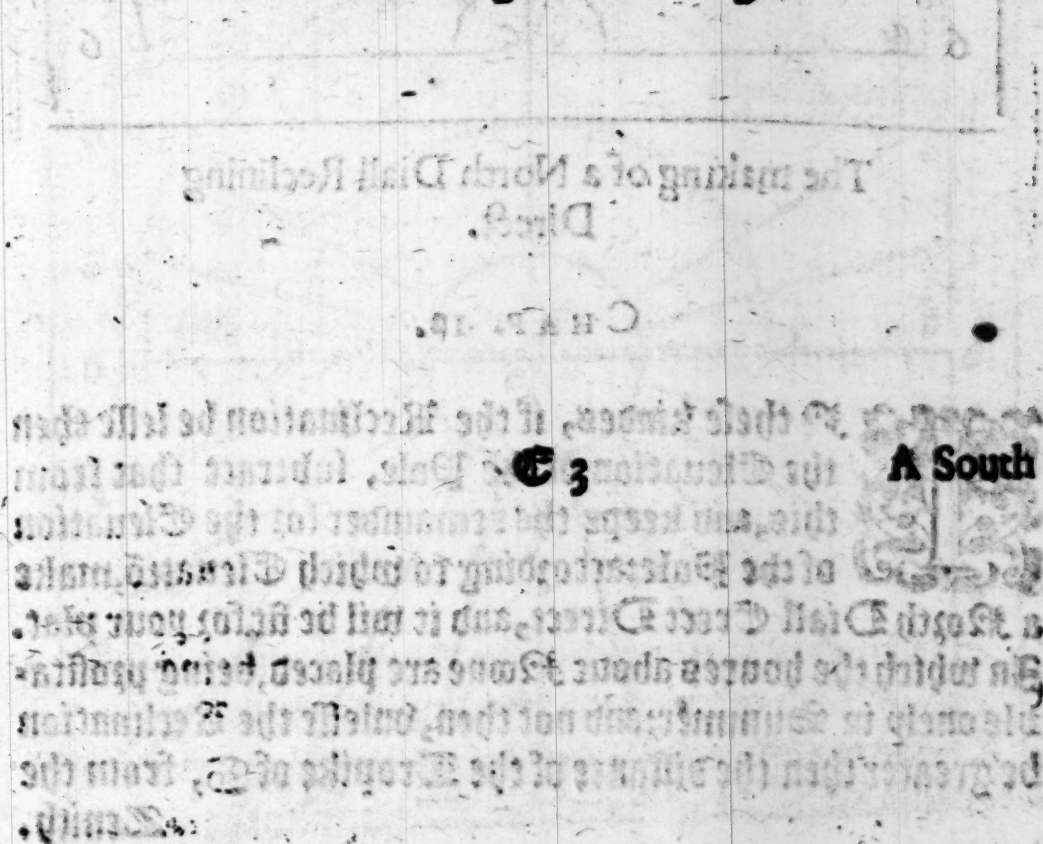
**F**irst, I take the complement of the Elevation, which is 38.d. out of the reclination of the plat which is 55.d. and there remaine 17.d. which number keepe for the Elevation of the Pole.

# The Art of Dialling. 15

In Delineation of this Diall, draw a line Parallell to the Horizon A.B. draw another C.D. making right angles with the line A.B. Then make the quadrant from A. to D. which being divided into 90. degrees, number in it, that, which is, as it were the Elevation of the Pole, namely 17. degrees from D. towards A. Then draw the line of Contingence K.L. in any point of the line C.D. squirewise. Take with your compasses the least distance of the point G. and of the Style: extend them forth in the line C.D. I meane, from G. toward C. make there a point marked with E. upon which point or centre with the same widenesse of the compasses, draw the Equator from H. by G. to I. divide it into 12. equall parts, &c.

I finish that which remaineth in all respects, like to the Horizontall Diall, in naming the houres, drawing of the lines, fixing of the Style, &c. for in this kinde of Diall, the Style must be fixed in the centre C. standing upward, with so great an angle, as C.D.F. is.

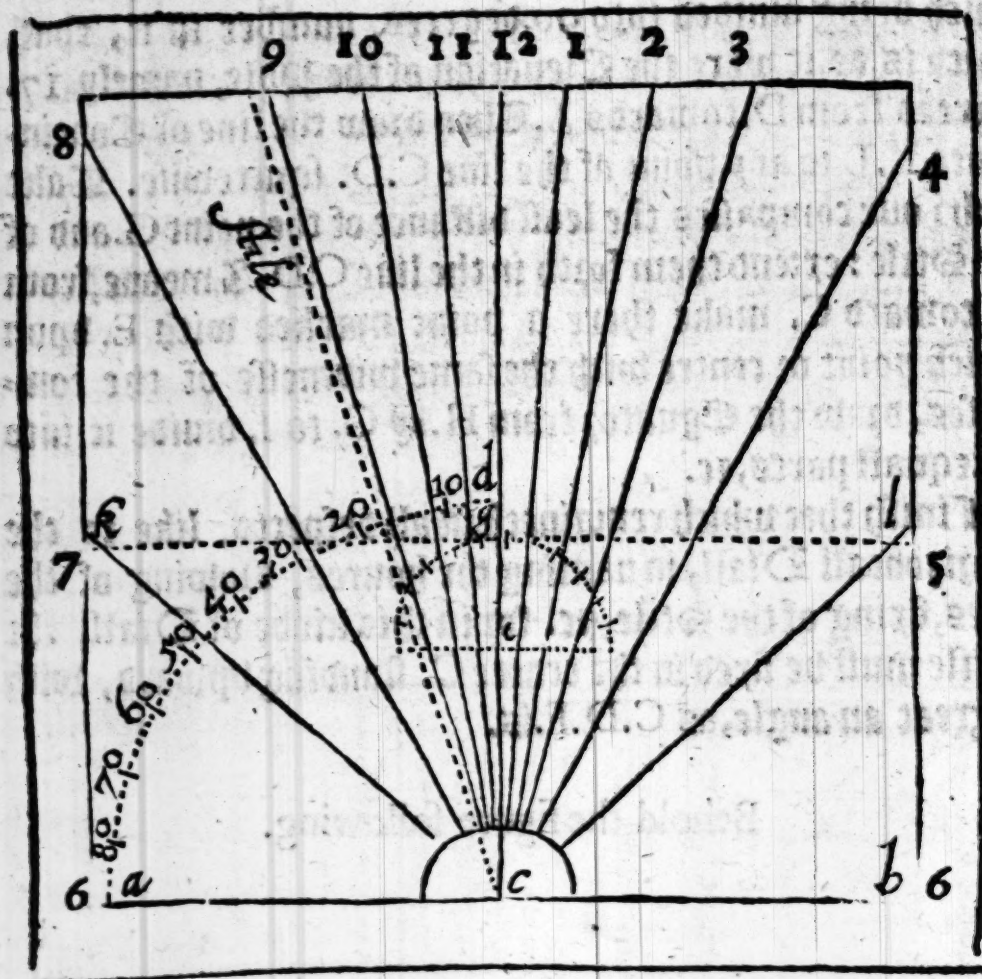
Behold the figure following.





# The Art of Dialling.

A South Reclining Erect.



The making of a North Diall Reclining Direct.

## CHAP. 12.

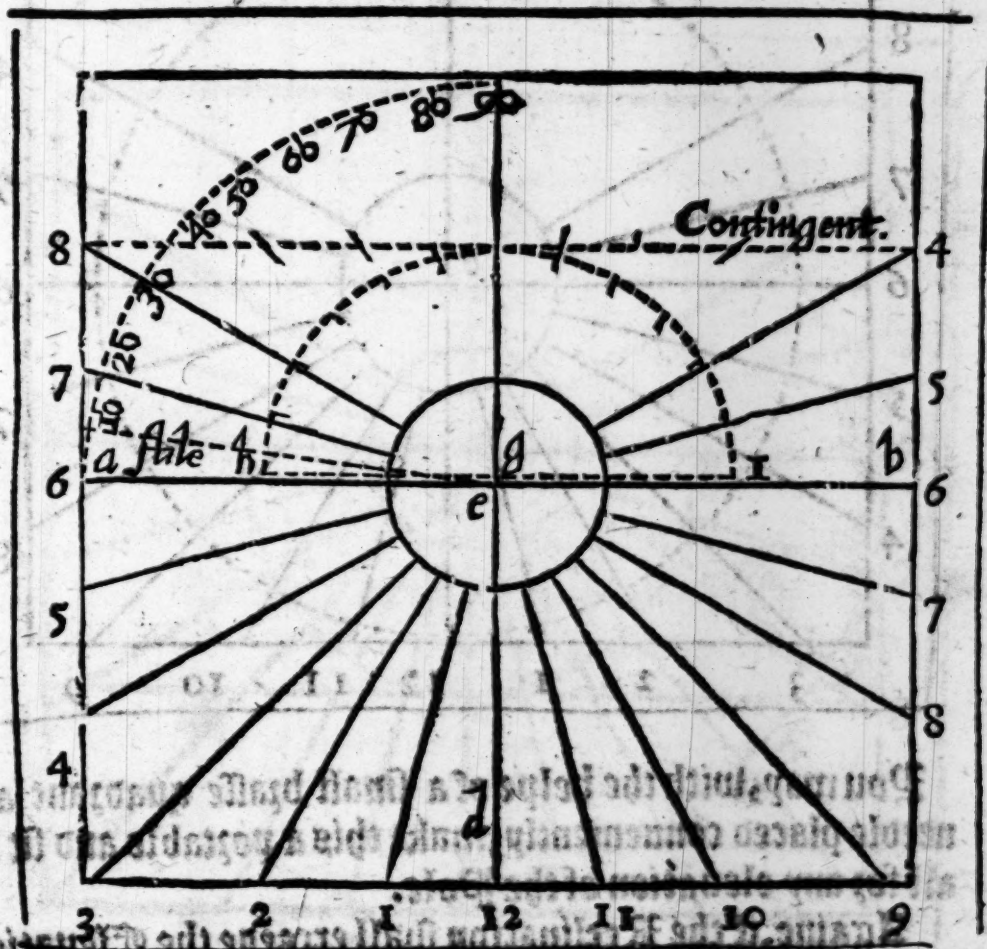
**I**n these kindes, if the Reclination be lesse then the Elevation of the Pole, subtract that from this, and keepe the remainder for the Elevation of the Pole: according to which Elevation, make a North Diall Erect Direct, and it wil be fit for your plat. In which the houres about Noone are placed, being profitable onely in Summer: and not then, vnlesse the Reclination be greater then the distance of the Tropike of  $\text{Cancer}$ , from the Zenith.

**Zenith.** And the more your Diall reclineth, the longer time it will shew in Summer.

Example of a North Diall reclining 45. degrees.

**F**irst, I take the Elevation of the Pole (which wee account 52.d.) out of the Reclination of the plat, which is 45.d. and there remaine 7.d. which shall bee in place of the Elevation of the Pole.

Then for the drawing of it, resort to the North Erect Direct, because their Delineation is like: remembryng alwayes to call that which remaineth, the Elevation of the Pole: which in this example is but 7.d. In the Figure following you see, that most part of the houre lines be drawne opposite from the Contingent, beyond the centre E. as you must doe in any of this kinde, if you will haue the houres about noone.



Example

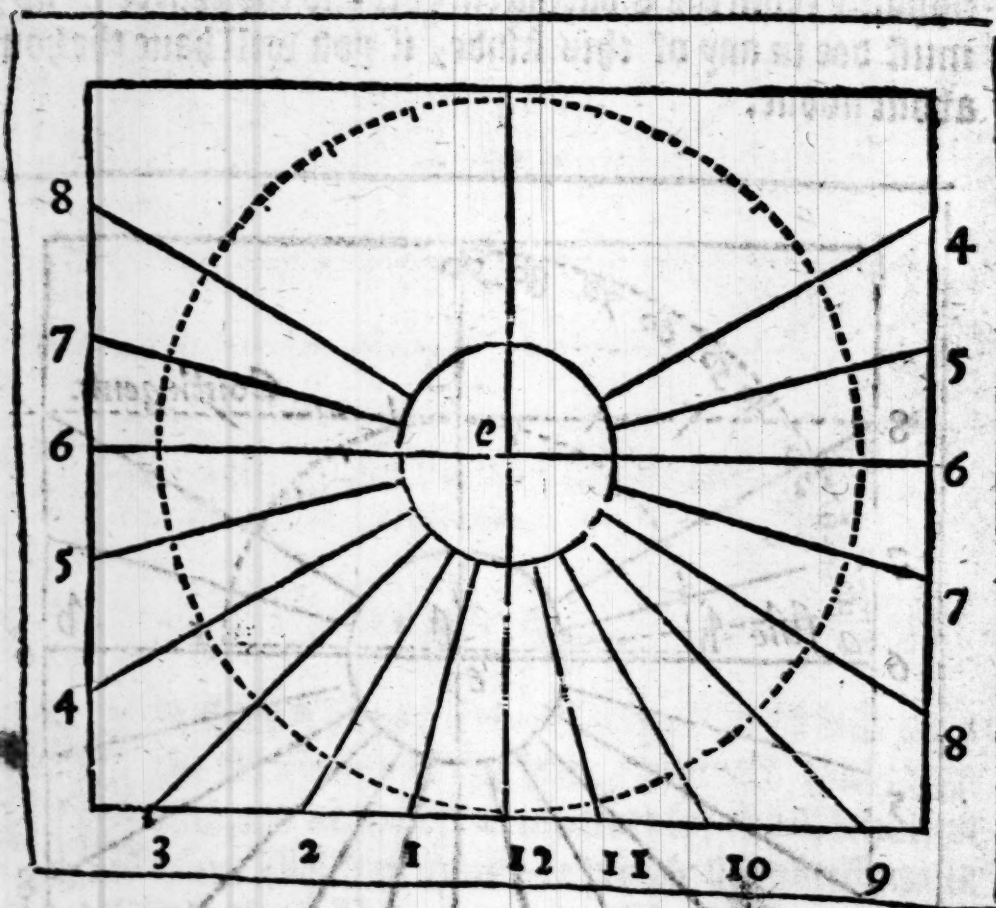


# The Art of Dialling.

Example of a North Diall Reclining 52. degrees.

**B**ut if the reclination be equall with the Elevation of the Pole: then describe a circle vpon the centre E. & diuide it into 24. equal parts, beginning the diuision at the 12. houre. Draw by those points, lines for the houres from the centre E. so many as shall be necessary: erecting the Stile (being some small wyer) in the centre E. right vp. This kinde of Diall serueth only when the Sunne is in the North signes which be  $\gamma$ ,  $\delta$ ,  $\Pi$ ,  $\zeta$ ,  $\alpha$ ,  $\mathfrak{m}$ .

A North Reclining Direct.



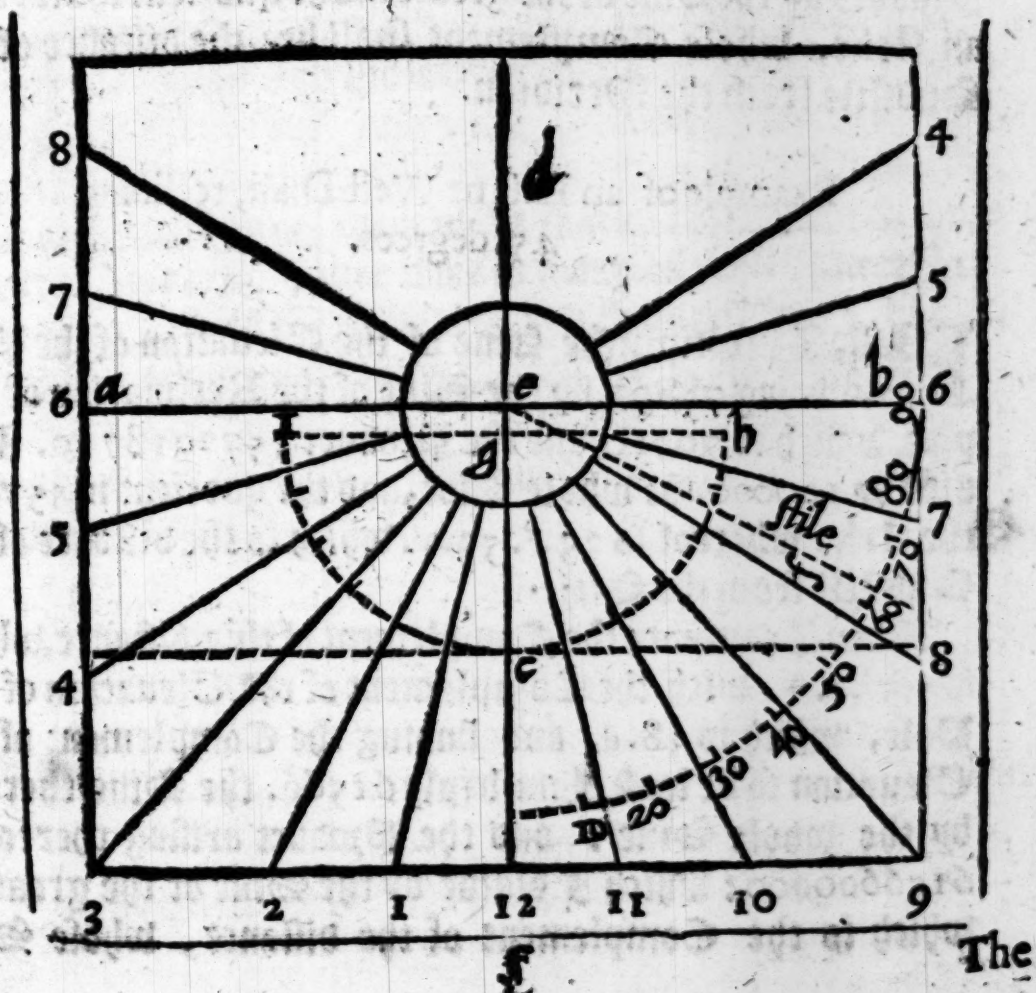
You may, with the helpe of a small brasse quadrant and a needle placed conueniently, make this a portable and fix Di-  
all for any elevation of the Pole.

Againe, if the Reclination shall exceede the Elevation of  
the

## 17

**Example of a North Dial reclining 80.d.**

A North Declining Direct.





# The Art of Dialling.

The making of an East and West  
Dial reclining.

C H A P. 13.



First, multiply the Sine of the elevation of the Pole, by the Sine of the Reclination of the plat, and divide the product by the whole Sine: whereof shall come a quotient, whose arke is the distance of the Stile, from the Substile.

Compare the Complement of this distance with the complement of the Elevation of the Pole, and which you shall finde least, multiply the signe thereof by the whole Sine, parting the Product by the Sine of the greater. The quotient shall yeeld an Arke, whose Complement shall bee the distance of the Substile from the Meridian.

Example of an East or West Dial, reclining  
45. degrees.

First, I multiply the Sine of the Elevation of the Pole 52.<sup>d.</sup> being 78801. by the Sine of the Reclination of the plat, which is 70710. and the Product 5572018710. I divide by 100000. the whole Sine, and the quotient is 55720. the Arke whereof is 33.<sup>d.</sup> 52.<sup>m.</sup> which is the distance of the Substile from the Stile.

Then I compare the Complement of this distance, which is 56.<sup>d.</sup> 8.<sup>m.</sup> with the Complement of the Elevation of the Pole, which is 38.<sup>d.</sup> and finding the Complement of the Elevation to be least, I multiply 61566. the Sine thereof, by the whole Sine: and the Product arising thereof is 615660000: which I divide by the Sine of the greater, which is the Complement of the distance, whose Sine is

is 83033. And the quotient 74141. yeeldeth an Arke 47.d. 51.m. whose Complement is 42.d. 9.m. which is the distance of the Substile from the Meridian.

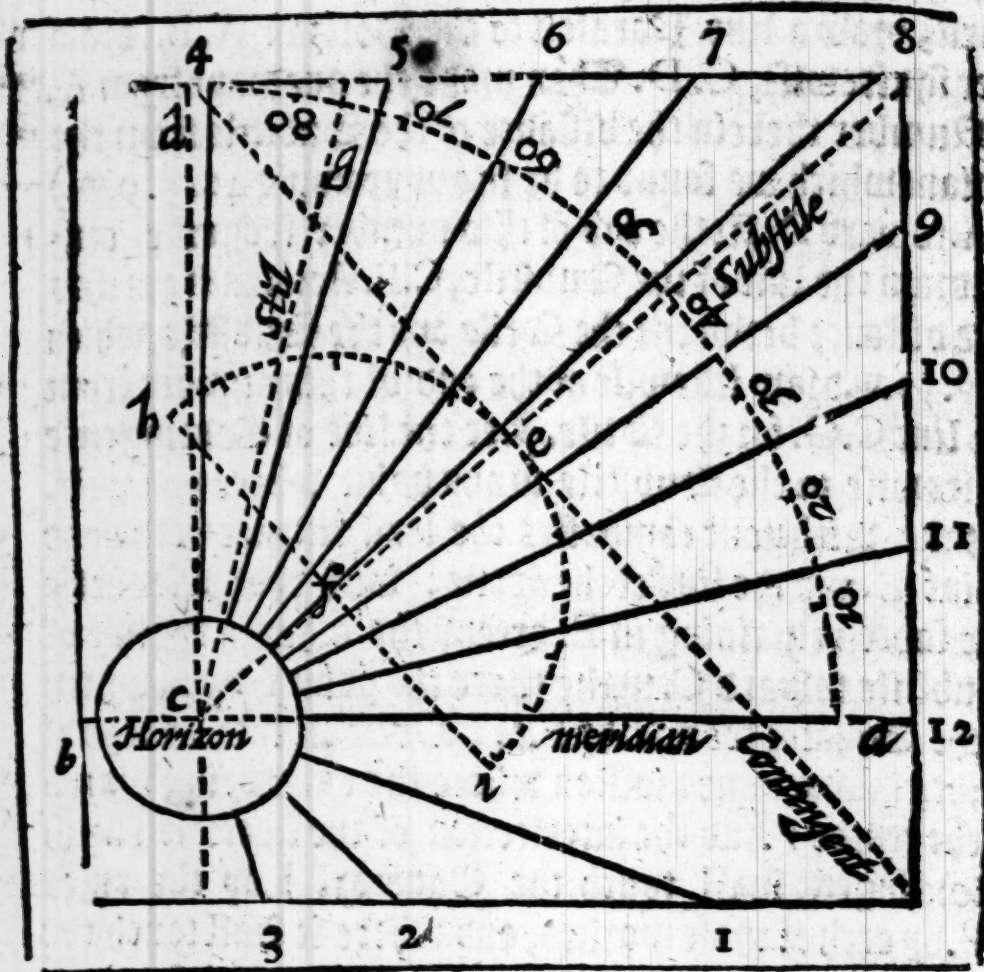
First, draw a line Paralell to the Horizon A.B. draw another squirewise, C.D. Then make the quadrant from A. to D. Number therein the distance of the Substile from the Meridian (which we found to be in our example 42. d. 9. m.) from A. toward D. At the end of this number from the centre C. draw the line of the Substile, C.E. Account from this line the distance betweene the Stile and the Substile, which is 33. d. 52. m. draw likewise at the end of this number from C. the line C.G. for the Stile. Let the line of Contingence be squirewise to the Substile in any point where you will. Then take with your compasses the least distance betweene the point E. and the line of the Stile: with that widenesse the one foote remaining in E. extend the other in the line of the Substile toward C. make there the point F. vpon which draw the Equator from H. by E. to I. Diuide it into 12. equal parts; beginning your diuision where the ruler being placed vpon the centre F. and the intersection of the Meridian with the Contingent shall touch the Equator. Lay the ruler from F. by each of those markes, and where it shall touch the line of Contingence, there make markes: by which from the centre C. draw the houre lines so many as shall be necessary. The line A.B. is the Meridian, and sheweth the 12. houre. Finish al other things, as in the rest before you were taught.

Note that if it be an East diall, you must make the quadrant from A. to D. If a West, from B. to D. Finish the residue as before, &c.



# The Art of Dialling.

An East or West reclining.



The making of a South reclining declining Diall.

## CHAP. 14.



First, in this kinde, as in other which follow, you must finde out and place the Meridian, the Substile, and the Stile, which being done, that which remaineth is finished as in those before.

Therefore the Declination and the Reclination of the platte being knowne by your Instrument, multiply the Sine of the declination by the Sine of the

the complement of the Reclination, diuiding the product by the whole Sine. The quotient Sine shall yeelde an Arke, whose complement shall be named the Complement to bee repeated.

Afterward augment the Sine of the Complement of the Declination, by the whole Sine, diuide the Product by the Sine of the complement to bee repeated : whereof shall come a Sine, whose Arke shall be the distance of the Meridian from the Horizon.

Againe, multiply the Sine of this distance, by the Sine of the complement of the Reclination, part the Product by the whole Sine, the Arke of whose quotient shall be called the Eleuation of the Meridian.

Then compare this Eleuation of the Meridian, with the Eleuation of the Pole, and which you shall finde least, subtract that from the greater, and that which remaineth keepe, ( for it shall bee called the difference kept ) being mindfull which of them was the greatest.

This done, multiply the Sine of the Complement to be repeated by the Sine of the difference kept : diuiding the Product by the whole Sine, whereof shall come a Sine, whose ark shall be the distance of the Stile from the Substile :

To conclude, compare the Complement of this distance with the complement of the difference kept, and which you shall finde least, multiply the Sine thereof by the whole Sine : part the Product by the Sine of the greater, and thereof shall come a Sine, the Complement of whose Arke shall be the distance of the Substile from the Meridian.

Example of a South Diall  $\left\{ \begin{array}{l} \text{Declining } 18. d. \\ \text{Reclining } 25. d. \end{array} \right.$

First looke out in the Table the Sine of the Declination, which is 30901. Then the Complement of the Reclination being 65. d. the Sine hereof is 90630. Afterward multiply 90630. by 30901. and the product 2800557630

If 3

diuide



# The Art of Dialling.

diuide by the whole Sine, which is 100000. the quotient shall be 28005, whose arke is  $16^{\circ}.16^{\prime}$ . The complement whereof being  $73^{\circ}.44^{\prime}$ . is the Complement to be repeated.

This done, multiply 95105. the Sine of the Complement of the Declination  $72^{\circ}$ . by the whole Sine 100000. the product shall be 9510500000. which being diuided by 95996. the Sine of the complement to be repeated, the quotient shall be 99071, whose arke is  $82^{\circ}.11^{\prime}$ . which is the distance of the Meridian from the Horizon.

Afterward augment the Sine of this distance 99071. by the Sine of the complement of the Reclination, which is 90630, and the product 8978804730. part by the whole Sine: and the quotient 89788. shall yeeld an arke  $63^{\circ}.53^{\prime}$ . which is the Eleuation of the Meridian.

Then compare the Eleuation of the Meridian, with the Eleuation of the Pole, which in this example is  $52^{\circ}$ . and finding the Eleuation of the Pole to be least, subtract this (namely  $52^{\circ}$ .) from  $63^{\circ}.53^{\prime}$ . the Eleuation of the Meridian, & there remaineth  $11^{\circ}.53^{\prime}$ . which is difference kept.

Now multiply 95996 being the Sine of the Complement to be repeated, which is 20591. the Product is 1976653636. which diuided by the whole Sine, the quotient shall be 19766, whose arke is  $11^{\circ}.24^{\prime}$ . is the distance of the stile from the Substile.

Then to conclude, the Complement of this distance, which is  $78^{\circ}.36^{\prime}$ . being compared with the Complement of the difference kept, which is  $78^{\circ}.7^{\prime}$ . you shall finde the Complement of this difference kept to bee least, wherefore multiply 97856. the Sine thereof, by the whole Sine and the product 9785900000. part by the Sine of the greater, to wit, of the Complement of the distance of the stile from the Substile, which is 98027. the quotient shall be 99825. whose arke is  $86^{\circ}.37^{\prime}$ . The Complement whereof is  $3^{\circ}.23^{\prime}$ . which is the distance of the Substile from the Meridian.

There

There be three sundry kinds of these Dials, the one differing from the other.

## The first kinde.

Marke therefore if the Elevation of the Meridian be greater then the Elevation of the Pole, draw a line parallel to the Horizon. A. B. out of the middest whereof extend another C. D. squerewise to the line A. B. make the quadrant from A. to D. number therein from A. towards D. the distance of the Meridian from the Horizon, which is 82. d. 11. m. at the end hereof from the centre C. draw the line C. E. for the Meridian.

From which account backward towards A. the distance of the Substile from the Meridian, which is 3. d. 23. m. draw at the end of this number the line C. F. for the Substile.

Then from the Substile toward A. number the distance of the Substile from the stile 11. Degrees, 24. minutes, and at the end thereof extend the line C. G. which shall represent the stile. This done in the line of the Substile in the point F. (which you may take where you will in the Substile) draw the line of Contingence squerewise to the Substile. Then take the least distance of the point : F. from the stile.

Afterward extend your compasses, the one foote being placed in F. in the line of the Substile toward C. unto H. Describe vpon the centre H. the Equinoctiall circle by F. diuide it into 24. equall parts, beginning where the ruler shall touch the Equator, being placed vpon the centre H. and vpon euery marke of the Equator, and where the ruler shall touch the line of Contingence, there make markes, by which from the centre C. draw the houre lines so many as shall be necessary, C. E. alwaies shewing the 12. houre. Let the stile hang directly ouer the Substile with so great an angle as F. C. G. is: fixing it in the centre C. pointing

Northwards.

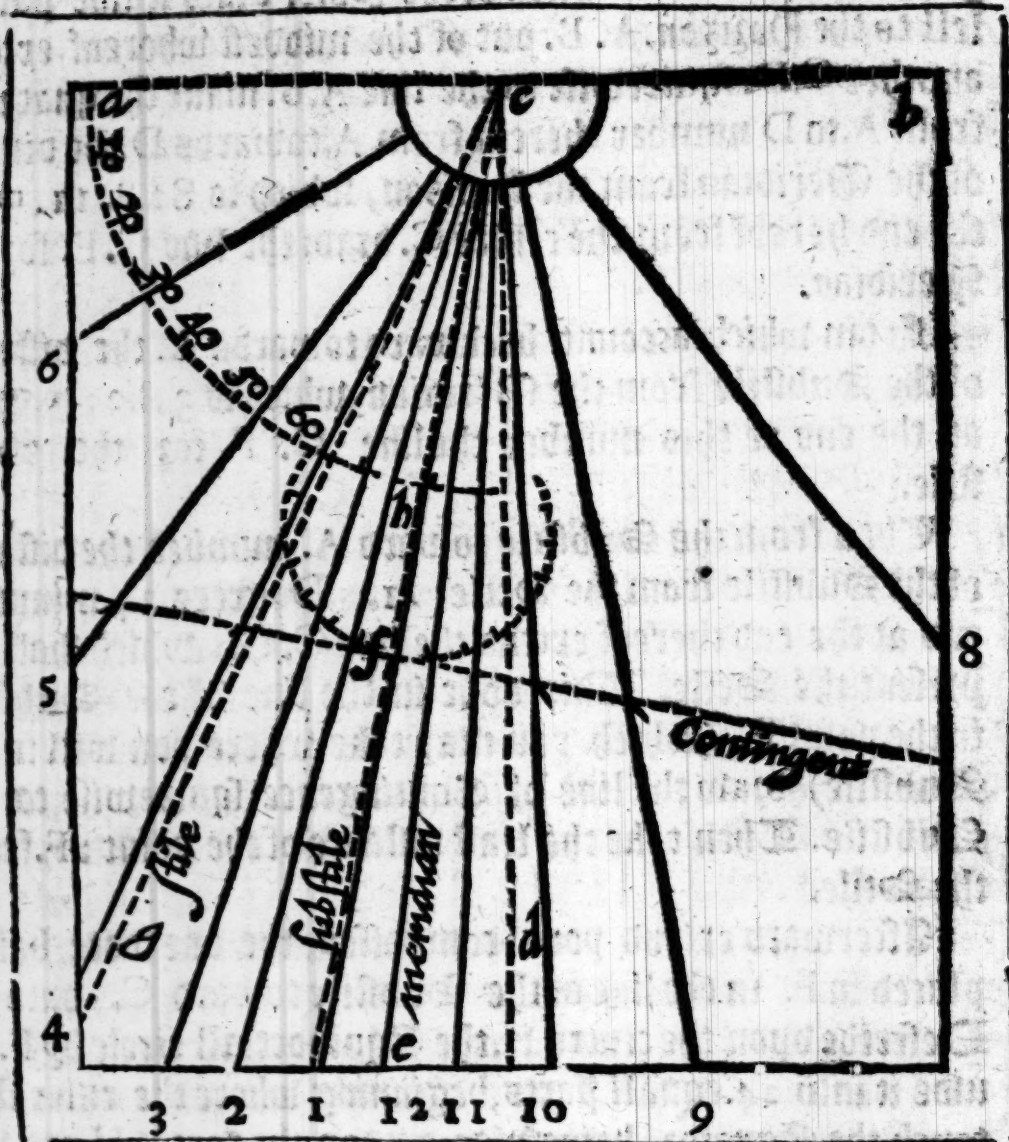


# The Art of Dialling.

downward to the Pole Antarticke.

Place the line A. B. paralell to the Horizon, having afterward, as other preparative lines, no use.

[A South Declining Reclining.]



The second Table.

But if the Elevation of the Pole, and the Elevation of the Meridian be found equall, the making of your Diall differeth from the former: yet the finding out of the Meridian and the Substile, &c. is wrought as in the other before, whither

whither you may resort. It shall be sufficient heere to shew  
an example of this kinde.

Example of a South Diall, whose  $\left\{ \begin{array}{l} \text{Declination is, } 32.^{\circ}. \\ \text{Reclination is, } 33.^{\circ}.30.^m. \\ \text{Elevation of the Pole is, } 52.^{\circ}.2.^m. \end{array} \right.$

First, I multiply 52991 the Sine of the declination, by  
83388 the Sine of the Complement of the Reclination,  
and the product 4418813508 arising thereof, I divide by  
the whole Sine: the quotient Sine 44188 yeeldeth an arke  
26. $^{\circ}$ .14. $^m$ . whose complement being 63. $^{\circ}$ .46. $^m$ . is the com-  
plement to be repeated.

Then I increase the Sine of the Complement of the de-  
clination, which is 84804, by the whole Sine, and the pro-  
duct is, 8480400000: which I parte by 89700, being the  
Sine of the complement to be repeated. The arke of whose  
quotient Sine 94541 being 70. $^{\circ}$ . 59. $^m$ . is the distance of  
the Meridian from the Horizon.

This done, I multiply this Sine 94541, by the Sine of  
the complement of the reclination, which is 83388, and the  
product arising hereof, being 7883584908, I divide by the  
whole Sine: the quotient thereof is 78835, whose arke 52. $^{\circ}$ .  
2. $^m$ . is the Elevation of the Meridian, which I compare  
with the Elevation of the Pole, and finding them equall, I  
end my worke heere. For this shall be sufficient in this kinde  
of Diall, as you may more plainly perceiue by the deline-  
ation of the Figure.

Wherefore if the Elevation of the Pole, and of the Me-  
ridian be found equall, (as in this example it is) make a line  
parallell to the Horizon A.B. Draw another C.D. making  
right angles with the line A.B. Draw the quadrant from  
A. to D. number therein the distance of the Meridian from  
the Horizon from A. toward D. which is 70. $^{\circ}$ . 59. $^m$ . being  
here in place of the Substile. Then draw the line of Con-  
tingence squire-wise to the Meridian C.E. (which is also the  
Substile)



Substile) C.E. in any point thereof, as before. Place one foot  
of your Compasses in the intersection E. then set the other  
foote in the Meridian (or Substile) being of any widenessse:  
make there the point or centre F. vpon which centre draw the  
halfe Equator from G. by E. to H. Divide the one halfe ther-  
of from E. towards H. into 90. d. Account therein from the  
Meridian E. towards H. the declination of the place 32. d. place  
the ruler vpon the centre F. and the end of this number, and  
where it shall touch the Contingent line, there make a  
marke, by this marke you must draw a line squire-wise to  
the Contingent line, which shall be for the 12. houre. And  
where the ruler shall touch the Equator, there begin to di-  
vide it into 12. equall parts, by which lay the ruler from  
the centre F. making in the line of Contingence markes for  
the other houre lines, all which shall cut the Contingent  
line squire-wise. Note that sometime in diuiding of the E-  
quator, the two parts at both ends next to the Semidiamete-  
ter G.H. shall both of them make but one whole part, bu-  
lesse you will make a whole circle for the Equator, and di-  
vide it into 24. parts.

Let the Style be a small taper standing right up in the  
point E. being so long as the Semidiameter of the Equator.  
It may be also a plate of iron or brasse fastened in the Sub-  
stile, so broad as the Semidiameter is, as in the East and  
West erect Dials, &c. Let the line A. B. be paralell to the  
Horizon. Finish all other things as before.



### Example of a South Diall

First, I multiply the Sine of the declination, being 70710



# The Art of Dialling.

by the Sine of the complement of the reclination which is likewise 70710, and the product 4999904100 I part by the whole Sine. The quotient is 49999 whose arke is 30.d. The Complement of this Arke is 60.d. which is the Complement to be repeated.

Then I increase the Sine of the Complement of the declination, which is likewise 70710, by the whole Sine, and the product thereof 7071000000 I divide by the Sine of the Complement to be repeated 86602: the quotient Sine 81649 yeeldeth an arke 54.d. 44.m. which is the distance of the Meridian from the Horizon.

Afterward I multiply this Sine 81649, by the Sine of the Complement of the Reclination, which is 70710: the product arising 5773400790 I part by the whole Sine, the quotient is 57734. The arke whereof is 35.d. 16.m. the Elevation of the Meridian: which I compare with the Elevation of the Pole (being in our example) 52.d. and finding the Meridian Elevation to be least, I subtract it out of the Elevation of the Pole, and there remaineth 16.d. 44.m. which is the difference kept.

This done, I augment 86602 the Sine of the Complement to be repeated, by 28791 the Sine of the difference kept, and the product 2493358182 coming hereof, I divide by the whole Sine, the quotient Sine 24933 yeeldeth an arke 14.d. 26.m. the distance of the Style from the Substile.

Now comparing the Complement of this distance being 75.d. 34.m. with the Complement of the difference kept, which is 73.d. 16.m. and seeing the Complement of the difference kept to be least: I multiply 95765 the Sine thereof, by the whole Sine, and the product 9576500000 I divide by 96843 the Sine of the complement of the distance, and 98886 shall be the quotient thereof, whose arke is 81.d. 27.m. The complement of this arke is 8.d. 33.m. which is the distance of the Substile from the Meridian.

In the delineation of this Diall, draw first as before a line

line Parallel to the Horizon A. B. extend another C. D. making right angles with the line A. B. Draw the Quadrant from A. to D. divide it into 90 degrees. In which account the distance of the Meridian from the Horizon, from A. towards D. which is  $54^{\circ}.44^{\prime}$ . draw at the end of this number the Meridian line from the centre C. which shall shew the 12 houre. Account from this toward D. the distance of the Substile from the Meridian, which is  $8^{\circ}.33^{\prime}$ . at the end hereof extend from C. the line E. for the Substile. From this number the distance of the stile being  $14^{\circ}.16^{\prime}$ . toward D. if there be so much space, if not, account it from the Substile toward A. make at the end of this number the line C. F. for the stile. Let the line of Contingence cut the Substile square-wise, in what point you will. Finish all other things, as in the first of these three kinds of South reclining declining Dials.

In this kinde of reclining Dials, whose stile must be placed from the centre C. upward toward the Pole Arctike: if at any time you cannot draw to both ends of the Contingent line so many houre lines as shall be necessary: then prolong beyond the centre C. the lines opposite on the other side. As if you would make the 8. houre line for the morning, draw the 8. for the evening beyond the centre C. and you shall have your desire.

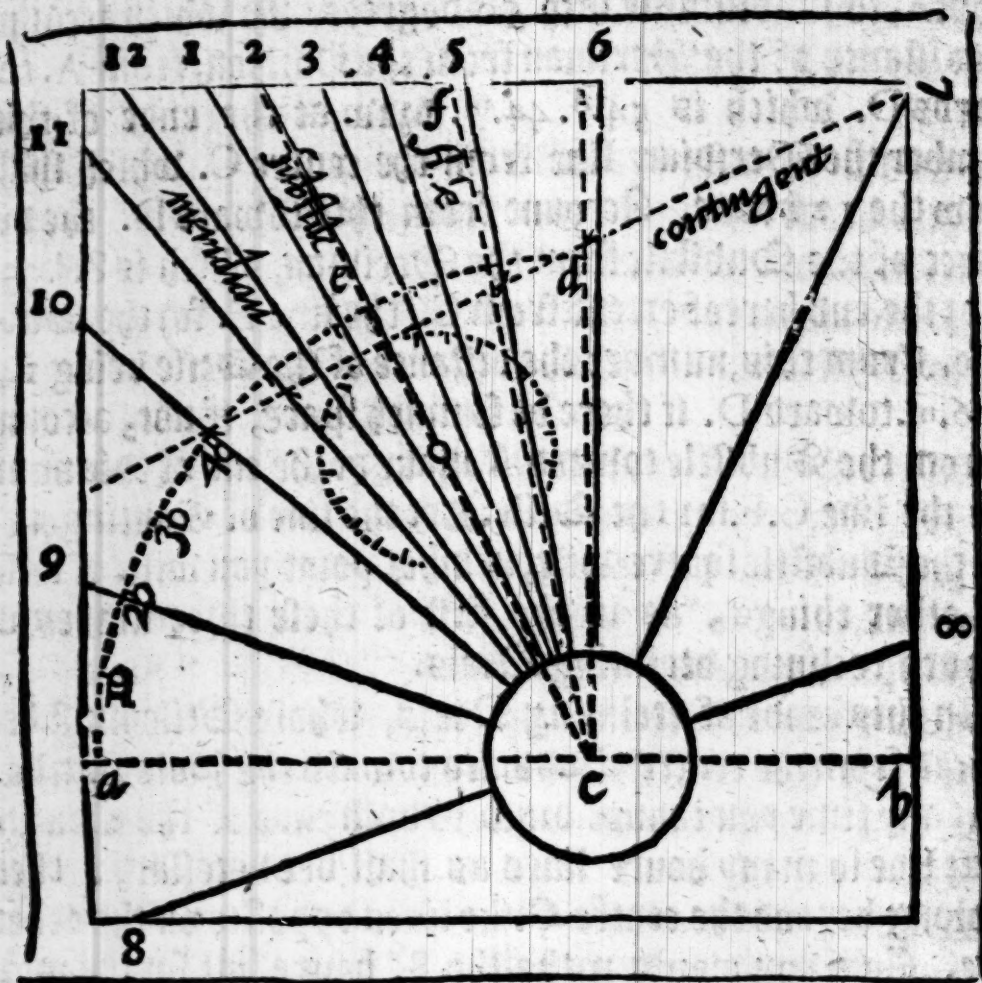
Note that moreover, in this kinde contrary to the other before, if the plat decline toward the West, (as in this example it doth) then draw the Quadrant toward the West, &c. But if the Declination be toward the East, make the quadrant toward the East.



A South



**A South reclining declining.**



## The making of a North reclining declining Diall.

## CHAP. 15.

## The first kind.

**I**n this kinde, as in the South before: first, multiply the Sine of the declination, by the Sine of the Complement of the Reclinati-  
on: parting the product by the whole Sine.  
The Quotient Sine thereof shall yeeld an  
Arke, whose Complement shall be called the  
Complement repeated.

五

Then increase in the Sine of the complement of the Declination by the whole Sine, divide the product by the Sine of the Complement repeated: the quotient Sine thereof will give an Arke, which shall be the distance of the Meridian from the Horizon.

The same quotient Sine multiply by the Sine of the Complement of the declination: and the number arising part by the whole Sine: the Arke of this quotient is the Elevation of the Meridian.

Now adde the Elevation of the Pole to the Elevation of the Meridian, and the totall number of Arke hereof, wee will call the compounded Arke. And if the compounded Ark be lesse than 90 degrees: then multiply the Sine thereof, by the Sine of the Complement repeated, dividing the product by the whole Sine: and hereof shall arise a quotient Sine, whose arke shall be the distance of the Style from the Substile.

Now compare the Complement of this distance, with the Complement of the compounded Arke: and increase the Sine of the lesse by the whole Sine, part the product by the Sine of the greater: and thereof shall come a Sine, the Complement of whose Arke shall bee the distance of the Substile from the Meridian.

But marke here the diuersity which doth arise by reason of the compounded Arke: for hereby you shall haue three sundry waies, both in finding out the distances betweene the Meridian and the Horizon, the Style and Substile, &c. And likewise in the declination of the figure. Whereof ariseth three sundry kindes of Dials: the first of them being already taught.

### The second kinde.

If the compounded Arke be iust 90 degrees: then the distance of the Style from the Substile shall bee the Complement repeated: and the distance of the Substile from the Meridian shall be also 90 degrees.

Note



Note that in the working hereof, there is no difference from the first kinde. For here, as in the other before, you shall first finde out the complement repeated: then the distance of the Meridian from the Horizon: Afterward the Elevation of the Meridian, which being added to the Elevation of the Pole, if the totall number bee iust 90.<sup>d</sup>. you shall not neede to proceede forward, for this (as before I made mention) shall bee the distance of the Meridian from the Substile.

In this kind you shall haue no intersection of the Meridian and the Contingent line: therefore you shall begin the diuision of the Equator at the line of the Substile, which shall shew the 6. houre, either in the morning, or evening, according as the place doth decline.

The third kinde.

But if the compounded Arke be greater then 90 degrees, subtract it from 180, and that which remaineth shall be called the difference kept. Then multiply the Sine of the Complement repeated, by the Sine of the difference kept, diuiding the product by the whole Sine, hereof shall come a Sine, whose Arke shall be the distance of the Stile from the Substile.

Then compare the Complement of this distance, with the Complement of the difference kept, increasing the Sine of the lesser by the whole Sine, and parting the product by the Sine of the greater: whereof shall come a Sine, the Complement of whose arke, being taken from 180 degrees the remainder shall shew how much the line of the Substile must be distant (vpward by the Horizon) from the Meridian. For the better vnderstanding of these three kinds, marke these three examples following, with the delineation of their figures.

Example

Example of a North Diall, } Declination is, 45.d.  
 whose } Reclination, 45.d.  
 } Eleuation of the Pole, 52.d.

First, I worke this altogether like to the South reck-  
 ning 45.d. declining 45.d. untill I haue found out the Ele-  
 uation of the Meridian.

Then I adde the Eleuation of the Meridian which is,  
 35.d. 16.m. to the Eleuation of the Pole 52.d. the totall  
 number is 87.d. 16.m. which is the compounded arke: and  
 being lesse than 90.d. I proceede with this arke, &c.

Now therefore I multiply the Sine of this compounded  
 arke, which is 99884, by the Sine of the complement to be  
 repeated being 86502, and the product 8650154168 I part  
 by the whole Sine. The quotient thereof is 86501, whose  
 arke 59.d. 54.m. is the distance betweene the stile and the  
 Substile.

Then I compare 30.d. 6.m. being the Complement of  
 this distance, with the Complement of the compounded arke,  
 which is 2.d. 44.m. and finding this least, I increase 4768  
 the Sine thereof, by the whole Sine, diuiding the product,  
 which is 476800000, by 50151 the Sine of the greater: the  
 quotient Sine yeeldeth an arke 5.d. 27.m. the Complement  
 hereof 84.d. 33.m. is the distance of the Substile from the  
 Meridian.

In the drawing of this Diall, first as before, make a line  
 parallel to the Horizon A.B. Then extend the line C.D. cut-  
 ting the other squire-wise. Marke the intersection or centre  
 with E. draw thereupon a circle A.B.C.D. whose two qua-  
 drants at the least, toward A. (if the plat decline West-  
 ward, or else toward B. if it decline Eastward) being diui-  
 ded into 90.d. each of them, number therein from A. to-  
 wards D. the distance of the Meridian from the Horizon,  
 which is 54.d. 44.m. and at the end hereof from the centre  
 E. draw the line F. for the Meridian, or 12 houre. Account

from

from

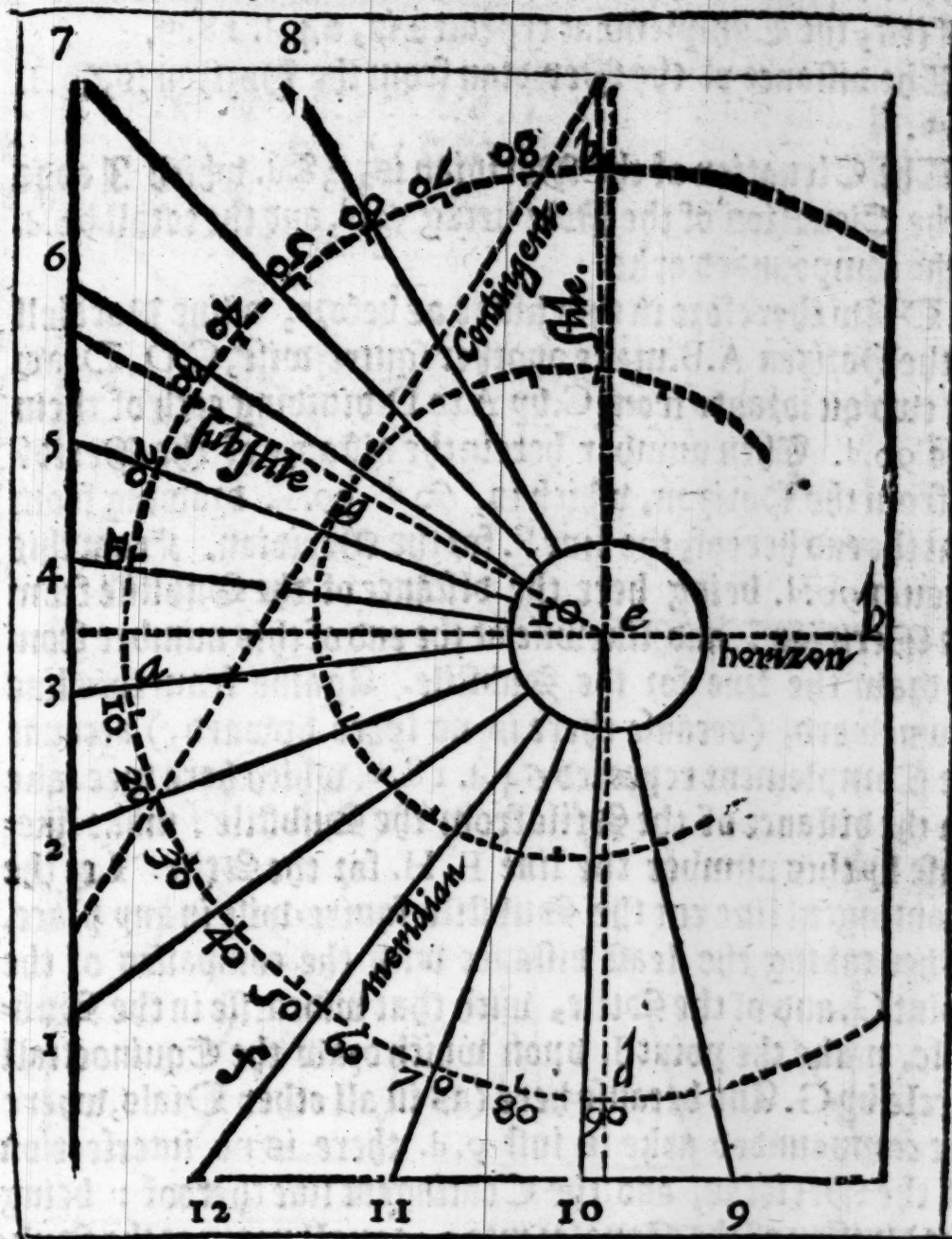


# The Art of Dialling.

from this upward toward C. the distance of the Substile from the Meridian, being  $84^{\circ}.33^{\prime}$ . make likewise at the end of this number from E. the line for the Substile. Again number from hence upward (if there bee so much space, or else downward)  $59^{\circ}.54^{\prime}$ . which is the distance betweene the Stile and the Substile, and at the ende hereof drawe the line H. for the Stile. Let the Contingent line cut the Substile square-wise in the point G. which you may take in any place of the Substile. Then with your compasses the least distance of this point G. and the Stile being taken, with that widenesse extend them forth in the line of the Substile toward E. making there the point I. upon which drawe the Equator or Equinoctiall circle. This done place the ruler upon the centre I. and the intersection of the Meridian and the contingent line, and where it shall touch the Equator there begin to divide it into 24 equall parts. Finish all other things, as in those which went before.

**A North**

A North reclining, declining.



The second kinde of North Diall, reclining 45 degrees  
14 minutes, declining 38 degrees.

**I**t shall not bee necessary to shew an example of this  
second kinde, because the Complement repeated, the  
distance of the Meridian from the Substile, and betweene  
the



# The Art of Dialling.

The Stile and Substile, &c. is found out altogether like to the other before, and that which followeth. Therefore it sufficeth to set downe the number of the distances.

First, the Complement repeated is, 64.d. 18.m.

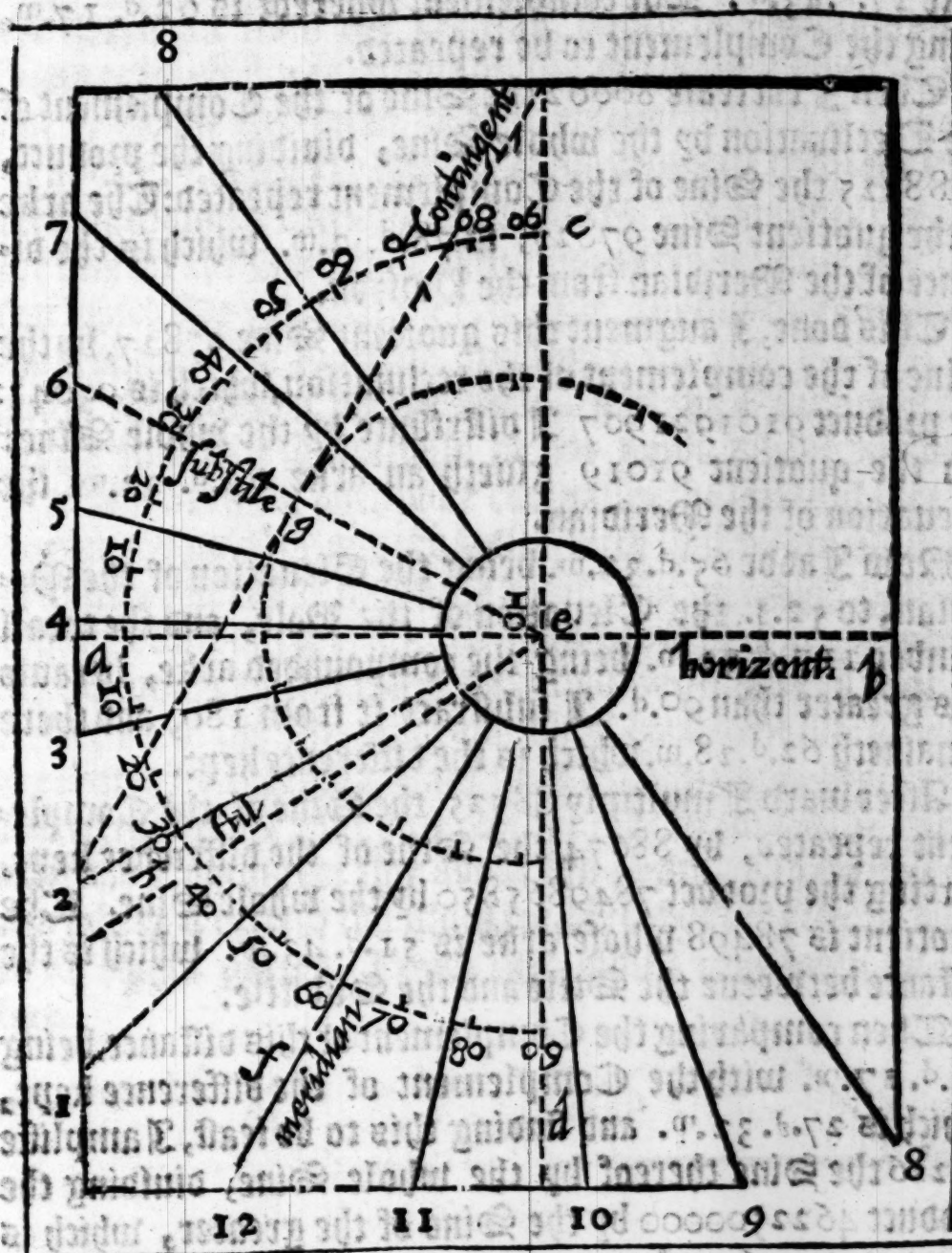
The distance of the Meridian from the Horizon is, 60.d. 59.m.

The Elevation of the Meridian is, 38.d. which I adde to the Elevation of the Pole being 52.d. and the totall 90.d. is the compounded arke.

Draw therefore in this kinde as before, a line Paralell to the Horizon A.B. make another squire-wise, C.D. Draw the two quadrants from C. by A. to D. diuiding each of them into 90.d. Then number herein the distance of the Meridian from the Horizon, which is, 60.d. 59.m. Drawing from E. at the end hereof, the line F. for the Meridian. From this account 90.d. being here the distance of the Substile from the Meridian: and likewise at the end of this number from E. draw the line for the Substile. Againe from this line downward, (because there is no space upward,) account the Complement repeated 64.d. 18.m. which here wee take for the distance of the Stile from the Substile: make likewise by this number the line E. H. for the Stile. Let the Contingent line cut the Substile squire-wise in any place. Then taking the least distance with the compasses of the point G. and of the Stile, with that widenesse in the Substile, make the point I. vpon which draw the Equinoctial circle by G. And because here (as in all other Dials, where the compounded arke is iust 9.d. there is no interfection of the Meridian, and the Contingent line thereof: being the diuision of the Equator into 24 equall parts at the Substile, which in this kinde shall shew the sixth houre, either in the evening or morning, according to the declination of the plat, Place the ruler vpon the centre I. and so many of these parts as you can, making markes in the line of Contingence as before, draw the houre lines by them, &c. finish the rest as in the other.

A North

## A North declining reclining.



Example of the third kinde } Reclining, 21.d. 30 m.  
 of North Dial before } Declining, 30.d.  
 mentioned.

Here first, as before, I multiply the Sine of the Declination being 50000, by 93041 which is the Sine of the complement



# The Art of Dialling.

complement of the reclination and the product 4652070000 I part by the whole Sine: the quotient 46520 yeeldeth an arke 27.<sup>d</sup>. 43.<sup>m</sup>. The complement whereof is 62.<sup>d</sup>. 17.<sup>m</sup>. being the Complement to be repeated.

Then I increase 86602 the Sine of the Complement of the Declination by the whole Sine, diuiding the product, by 88525 the Sine of the Complement repeated: The arke of the quotient Sine 97827, is 78.<sup>d</sup>. 2.<sup>m</sup>. which is the distance of the Meridian from the Horizon.

This done, I augment this quotient Sine 97827, by the Sine of the complement of the reclination, which is 93041: the product 9101921907 I distribute by the whole Sine: and the quotient 91019 giueth an arke 65.<sup>d</sup>. 32.<sup>m</sup>. the Elevation of the Meridian.

Now I adde 65.<sup>d</sup>. 32.<sup>m</sup>. being the Elevation of the Meridian, to 52.<sup>d</sup>. the Elevation of the Pole, and the totall number 117.<sup>d</sup>. 32.<sup>m</sup>. being the compounded arke, because it is greater than 90.<sup>d</sup>. I subtract it from 180, and there remaineth 62.<sup>d</sup>. 28.<sup>m</sup>. which is the difference kept.

Afterward I multiply 88525 the Sine of the Complement repeated, by 88674 the Sine of the difference kept, parting the product 7849865850 by the whole Sine. The quotient is 78498 whose arke is 51.<sup>d</sup>. 43.<sup>m</sup>. which is the distance between the stile and the Substile.

Then comparing the Complement of this distance, being 38.<sup>d</sup>. 17.<sup>m</sup>. with the Complement of the difference kept, which is 27.<sup>d</sup>. 32.<sup>m</sup>. and finding this to be least, I amplify 46226 the Sine thereof by the whole Sine, diuiding the product 4622500000 by the Sine of the greater, which is 61955 and 74612 the quotient coming hereof yeeldeth an arke 48.<sup>d</sup>. 15.<sup>m</sup>. whose Complement being 41.<sup>d</sup>. 45.<sup>m</sup>. I take out of 180, and the remainder is 138.<sup>d</sup>. 15.<sup>m</sup>. the distance of the Substile from the Meridian.

The delineation of the Figure.

First, as before, draw a line A. B. parallel to the Horizon,

A geometric diagram showing a triangle with a dashed line segment labeled '20' and '16'.

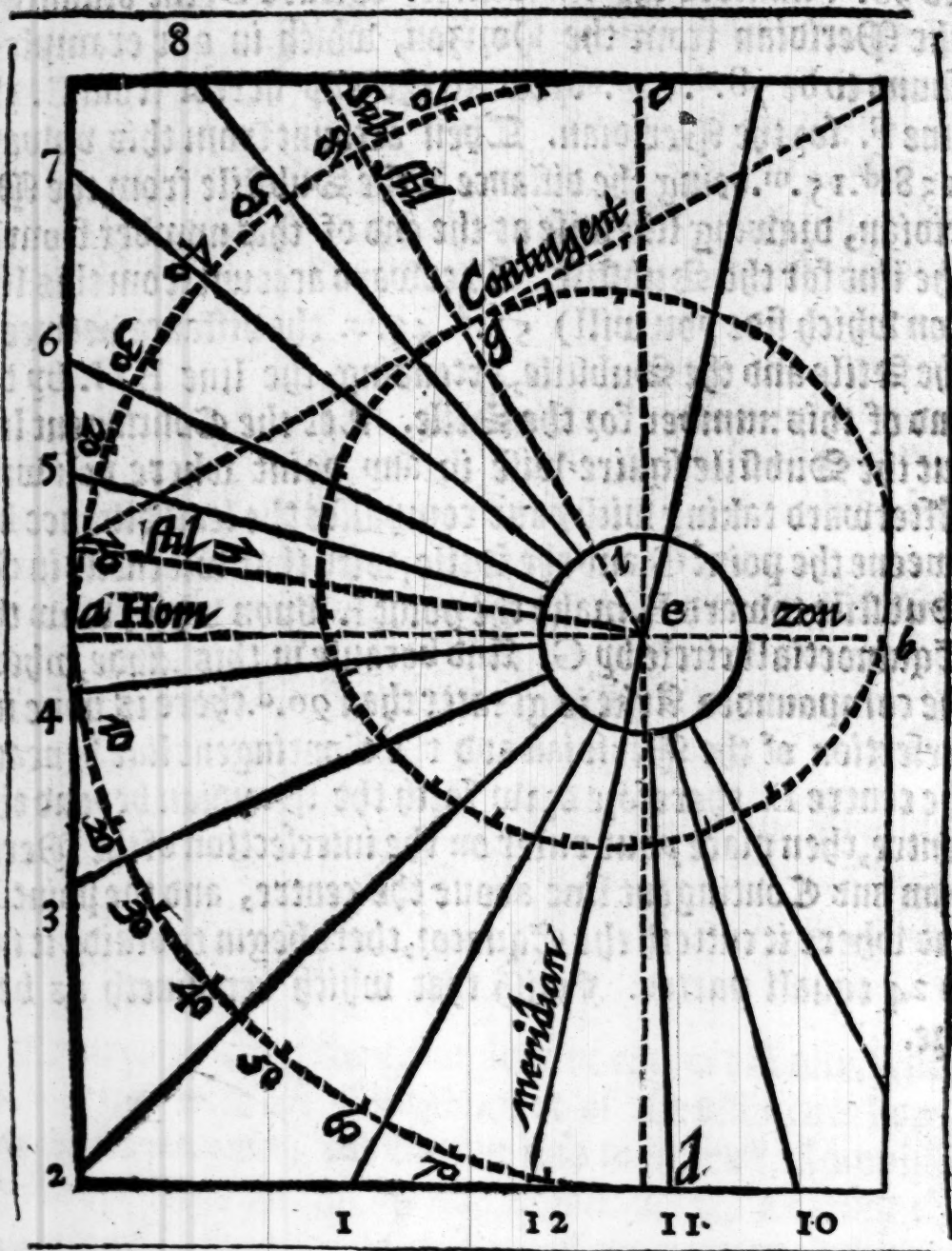
CHAP. IV.

## A North



# The Art of Dialling.

A North reclining declining.



The making of a South Inclining direct Diall.

CHAP. 16.

**I**f the inclination of the plat be lesse than the Elevation of the Pole, take that from this, accounting the remainder for the Elevation of the Pole. And with this number as if it were

where the Elevation of the Pole make a Dial like to the South erect direct, and it shall be fit for your plat.

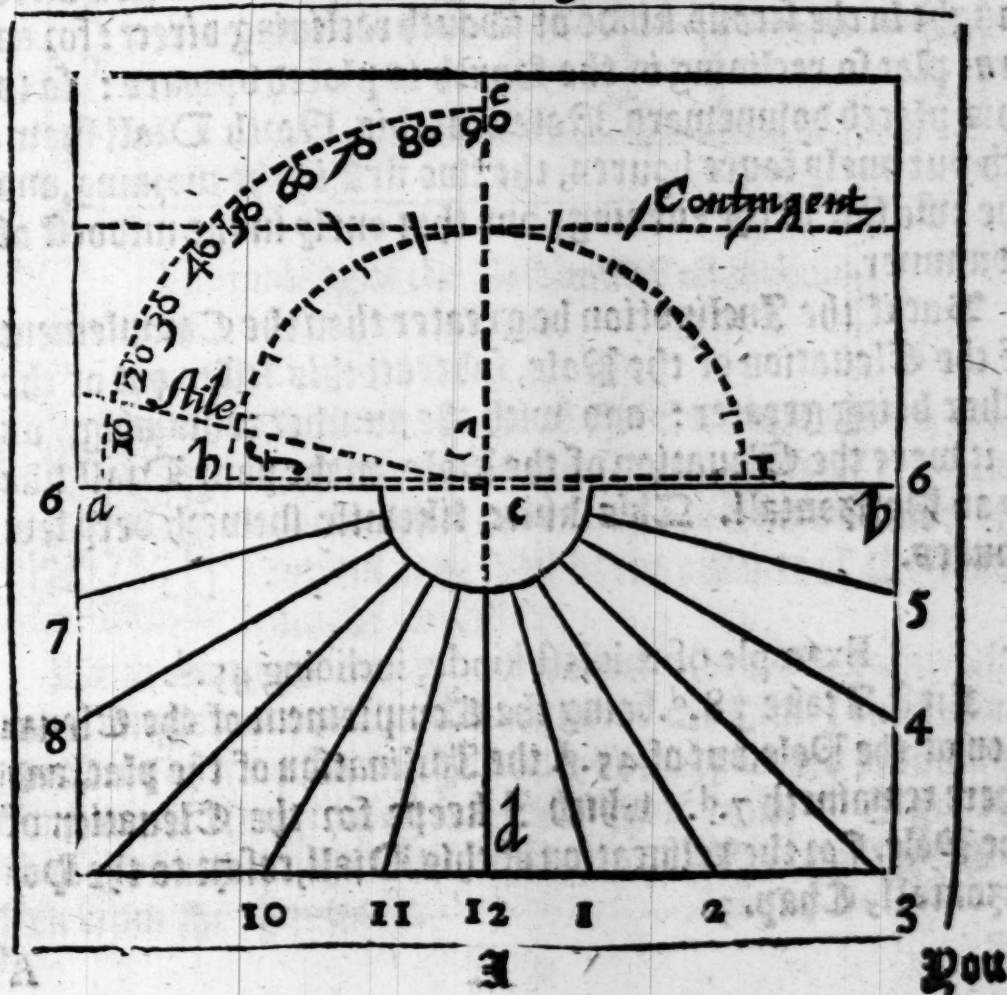
But if the Inclination of the place be equall with the Elevation of the Pole, make your Diall altogether like to the North reclining direct, whose reclinacion likewise is equall to the Elevation of the Pole. They differ onely herein, that this is placed downward to the earth, and that upward.

But if the Inclination of the plat bee greater than the Elevation of the Pole, subtract this from that, and with the number remaining, as if it were the Elevation of the Pole, make your Diall like to the Northerect direct.

Example of this kinde inclining 65.d.

Subſtra ct 52.<sup>d</sup>. the Elevation of the Pole, out of 65.<sup>d</sup>. being the Inclination of the plat, and the remainder 13.<sup>d</sup>. account the Elevation of the Pole. For the delineation hereof, reſort to the North erect Diall, Chap. 5.

**A South Inclining direct.**





# The Art of Dialling.

You see in this Figure, that all the lines for the houres are drawne opposite from the Contingent line, beyond the centre E. In like manner must you doe in the delineation of all such, which incline more than the Elevation of the Pole.

Let the Style in this kinde bee placed directly over the Meridian, with so great an angle as D. E. F. is, &c.

The making of a North Inclining direct Diall.

CHAP. 17.

**I**f the Inclination of the plat be lesse than the complement of the Elevation of the Pole, adde the Inclination to the Elevation: and with that number, as if it were the Elevation of the Pole, make a North erect direct Diall, for your plat.

But if the Inclination be equall with the Complement of the Elevation of the Pole, then make a Diall as you were taught in the second kinde of South reclining direct: for as that plat so reclining in the South is placed upward: so is this placed downward. Note that this North Diall sheweth but onely foure houres, the two first in the morning, and the two last in the evening, and that onely in the midst of Summer.

But if the Inclination be greater than the Complement of the Elevation of the Pole, subtract this lesser out of the other being greater: and with the number remaining, as if it were the Elevation of the Pole, make your Diall like to an Horizontall. This kinde likewise sheweth very few houres.

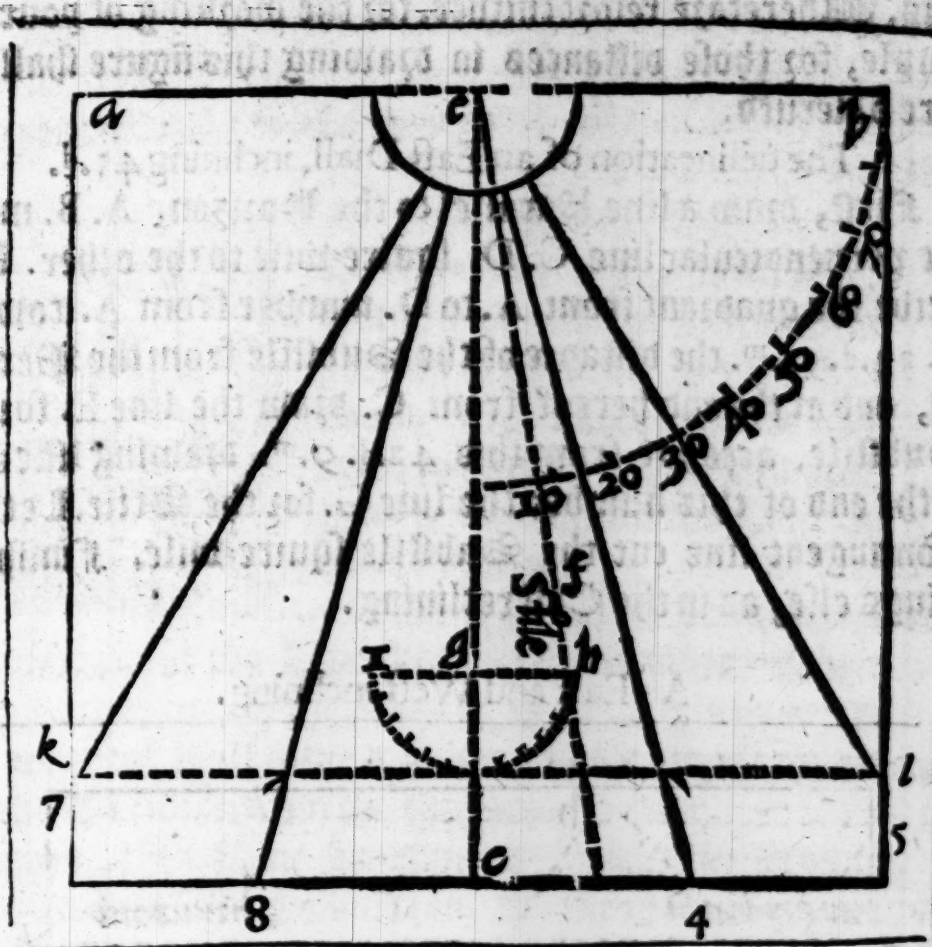
Example of this last kinde, inclining  $45^{\circ}$ .

First, I take  $38^{\circ}$ . being the Complement of the Elevation of the Pole, out of  $45^{\circ}$ . the Inclination of the plat, and there remaineth  $7^{\circ}$ . which I keepe for the Elevation of the Pole. For the delineation of this Diall, resort to the Horizontall, Chap. 3.

# The Art of Dialling.

30

A North inclining Direct.



The making of the East and West inclining  
Dials.

CHAP. 18.



Multiply the Sine of the Elevation of the Pole  
by the Sine of the Inclination of the plat;  
dividing the product by the whole Sine: the  
quotient arke shall be the distance of the Stile  
from the Substyle.

Then compare the Complement of this distance with  
the Complement of the Elevation of the Pole, increasing  
the Sine of the lesser by the whole Sine, part the product by  
the Sine of the greater, whereof shall come a Sine, the  
Complement of whole arke shall be the distance of the Sub-  
style from the Peridian.



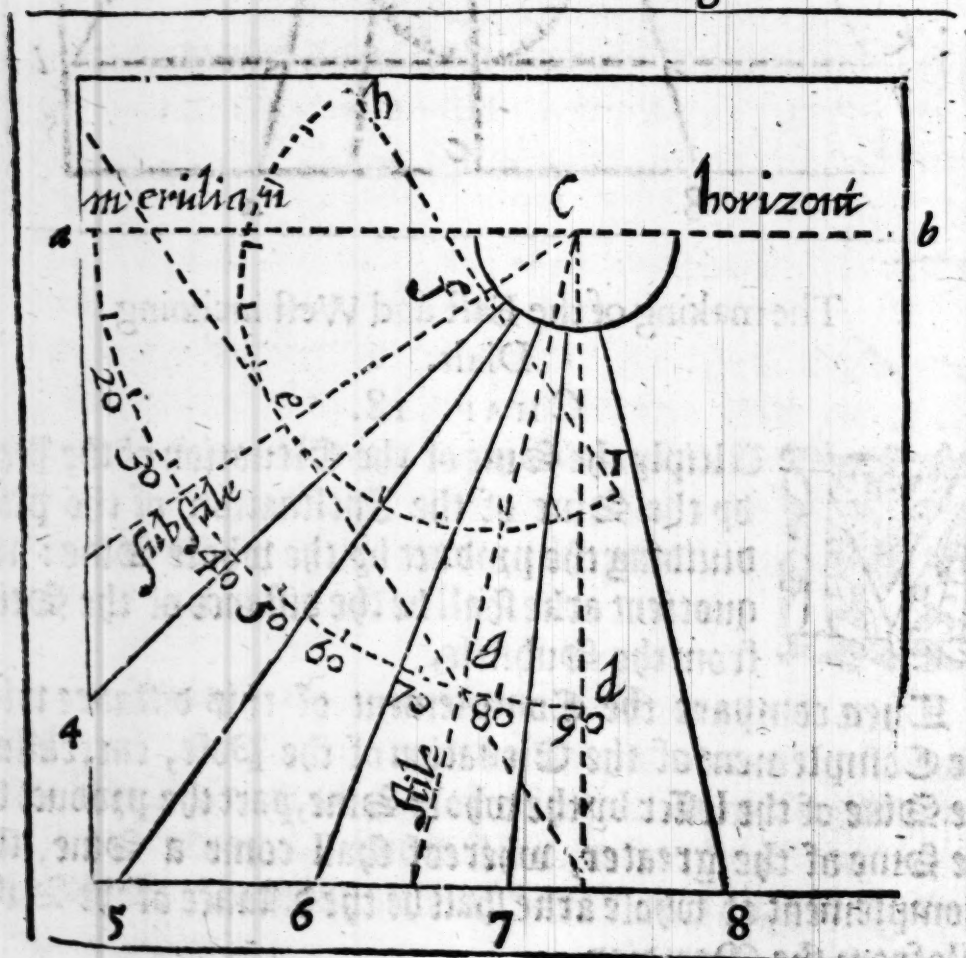
# The Art of Dialling.

It shall not be necessary to shew any example hereof, because the East and West reclining bee altogether like to this. Wherefore resort thither, for the working of your example, for those distances in drawing this figure shall bee here observed.

The delineation of an East Diall, inclining  $45^{\circ}$ .

First, draw a line Parallel to the Horizon, A. B. make the perpendicular line C. D. squire-wise to the other. Describe the quadrant from A. to D. number from A. toward D.  $33^{\circ}$ .  $52^{\circ}$ . the distance of the Substile from the Meridian, and at the end hereof from C. draw the line E. for the Substile, account from this  $42^{\circ}$ .  $9^{\circ}$ . drawing likewise at the end of this number the line G. for the Stile. Let the Contingent line cut the Substile squire-wise. Finish all things else, as in the East reclining.

An East and West inclining.



The

## The making of a South inclining declining Diall.

### CHAP. 19.



First, multiply the Sine of the Declination, by the Sine of the Complement of the Inclination, parting the product by the whole Sine. The quotient Sine shall yeeld an arke, whose Complement shall be named the Complement repeated.

Then increase the Sine of the Complement of the Declination by the whole Sine: and the product diuide by the Sine of the Complement repeated: whereof shall come a Sine, whose arke is the distance of the Meridian from the Horizon.

Afterward, this Sine being multiplied by the Sine of the Complement of the Inclination, and the product parted by the whole Sine: the arke of the quotient Sine shall bee the Elevation of the Meridian. Which Arke you must adde to the Elevation of the Pole. And if the totall number bee lesse than  $90^{\circ}$ . it shall be named the Doubtfull Arke. But if it bee greater than  $90^{\circ}$ . take it from  $180^{\circ}$ , and let the remainder be called the Doubtfull Arke.

This done, augment the Sine of the Complement repeated, by the Sine of the doubtfull Arke: and the product arising thereof being diuided by the whole Sine, the quotient Arke shall be the distance of the Style from the Substile.

Now compare the Complement of this distance, with the Complement of the Doubtfull Arke, multiplying the Sine of the lesser, by the whole Sine, diuiding the product by the Sine of the greater: the arke of the quotient Sine



# The Art of Dialling.

comming thereof shall bee the distance of the Substile from the Meridian.

But note, if the doubtfull arke be found without subtraction from 180, (which is if it bee lesse than 90.d.) then you must subtract the distance of the Substile from the Meridian out of 180, and the number remaining, shall be the true distance of the Meridian from the Substile.

Marke this likewise, if the doubtfull Arke be equall 90. degrees, let the Complement repeated bee the distance of the Stile from the Substile: then shall there be iust 90.d. for the space betwene the Substile and the Meridian, as before is taught in the North declining reclining, whither you may resort for the working hereof. Here it shall bee sufficient to shew two examples, with the delineation of their figures: the one, where the doubtfull Arke is subtracted from 180.d. and the other, where there is no subtraction hereof, because it is lesse than 90. degrees.

Example of a South Diall

Inclining 45. degrees.

Declining 45. degrees.

Inasmuch as this is altogether like to the North reclining 45.d. declining 45.d. whither you may resort: I will omit the working of the former part of this example, untill I come to the finding out of the distance of the Substile from the Meridian. The former part of this example you may find to be thus wrought in the North reclining declining.

First, the Complement repeated 60.d.

2 Then, the distance of the Meridian from the Horizon 54.d. 44.m.

3 Next, the Elevation of the Meridian 35.d. 16.m.

4 The compounded Arke there, which we call the doubtfull Arke here, 87.d. 16.m.

5 The distance of the Stile from the Substile 59.d. 54.m.

6 Last, the distance of the Substile from the Meridian 84.d. 33.m.

But

But here (as before is taught) you must subtract this distance from  $180^{\circ}$ . because the doubtfull Arke was lesse than  $90^{\circ}$ . and then the remainder  $95^{\circ} 27'$ . Shall bee the true distance of the Substile from the Meridian.

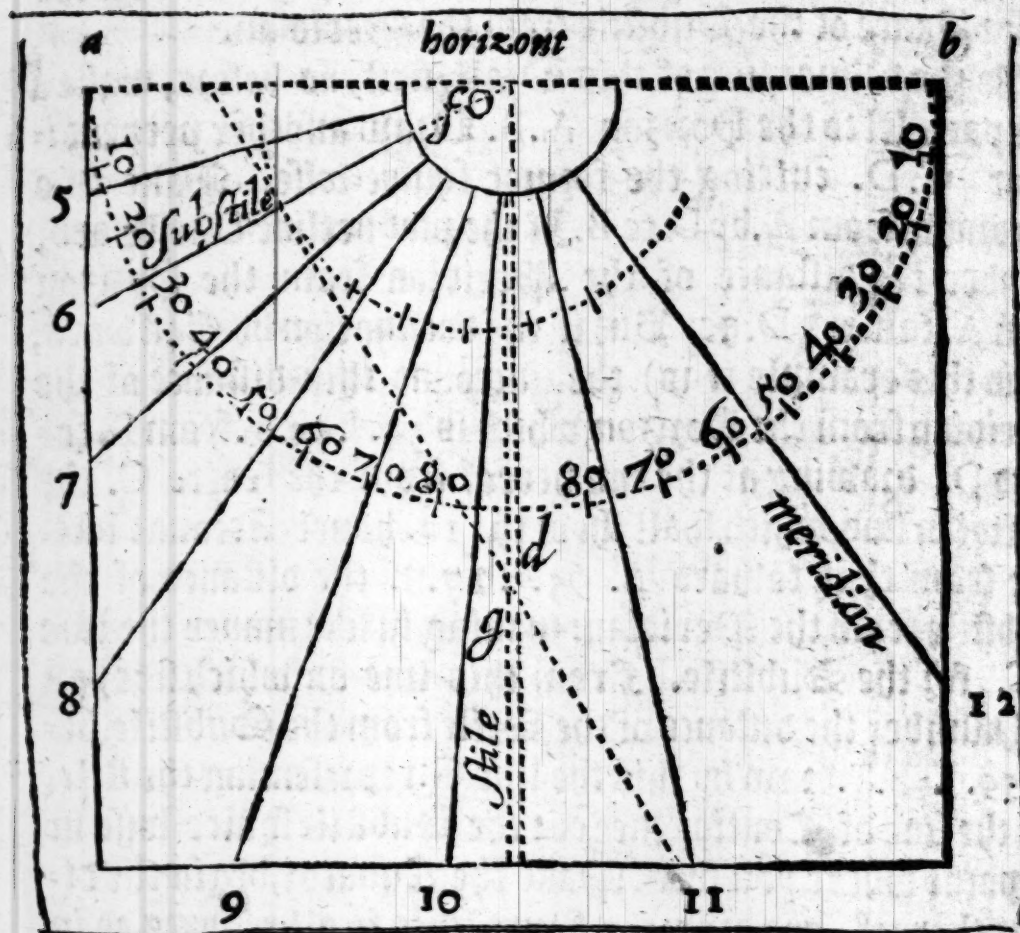
In the delineation of this Diall, first, as before, make a line parallel to the Horizon A.B. Draw another perpendicular C.D. cutting the former square-wise. Make two quadrants from A. by D. to B. If the plat decline Westward, number the distance of the Meridian from the Horizon from A. toward D. &c. But if the declination be Eastward, (as in this example it is) then account this distance of the Meridian from the Horizon, which is  $54^{\circ} 44'$ . from B. toward D. drawing at the end hereof from the Centre C. the Meridian line, which shall shew the 12. houre. Account likewise from that toward A.  $95^{\circ} 27'$ . the distance of the Substile from the Meridian: making in like maner the line E.C. for the Substile. From this line on which side you will, number the distance of the stile from the Substile, being  $59^{\circ} 54'$ . draw by this the line G. representing the stile. Let the line of Contingence cut the Substile square-wise in any point where you will. Make the Equator, begin the division thereof, and draw the houre lines in all respects as in the North reclining  $21^{\circ} 30'$ . declining  $30^{\circ}$ . Chap 15.

**A South**



# The Art of Dialling.

A South declining inclining Diall.



The second exam- { Inclining 33.d.4.m. } Where the doubt-  
ple of a South { Declining 31.d. } full Arke is sub-  
Diall. { } tracted from 180.

First, 51503 the Sine of the Declination being multi-  
plied, by 83227 the Sine of the Complement of the inclina-  
tion: and the product 4286440181 divided by the whole  
Sine: the Arke of the quotient is 25.d.23.m. The Comple-  
ment whereof being 64.d.37.m. is the Complement repea-  
ted.

Then I increase the Sine of the Complement of the de-  
clination, which is 85716, by the whole Sine, and I part  
the product 8571600000, by 90346. the Sine of the Com-  
plement repeated. The quotient 94875 yeeldeth an arke  
71.d.35.m.

71.d. 35.m. which is the distance of the Meridian from the Horizon.

Againe, I multiply this Sine 94875, by the Sine of the Complement of the Inclination being 83227, and the product 7895961425 arising thereof, I divide by the whole Sine. The Arke of the quotient is 52.d. 9.m. which is the Elevation of the Meridian.

Now this being added to the Elevation of the Pole 52.d. and the totall number 104.d. 9.m. taken from 180 there remaineth 75.d. 51.m. which is the doubtfull Arke.

Therefore I augment 90346 the Sine of the Complement repeated, by 96930 the Sine of the doubtfull arke, and the product 8760399890 I part by the whole Sine. The Arke of the quotient 61.d. 10.m. is the distance of the Substile from the Stile.

This done, I compare 28.d. 50.m. the Complement of this distance, with 14.d. 9.m. the Complement of the doubtfull arke, multiplying the Sine of the lesser, which is 24446 by the whole Sine, dividing the product 2444600000, by 48226 the Sine of the greater. The quotient Sine 50741 yeeldeth an arke 30.d. 30.m. whole Complement 59.d. 30.m. is the distance of the Substile from the Meridian.

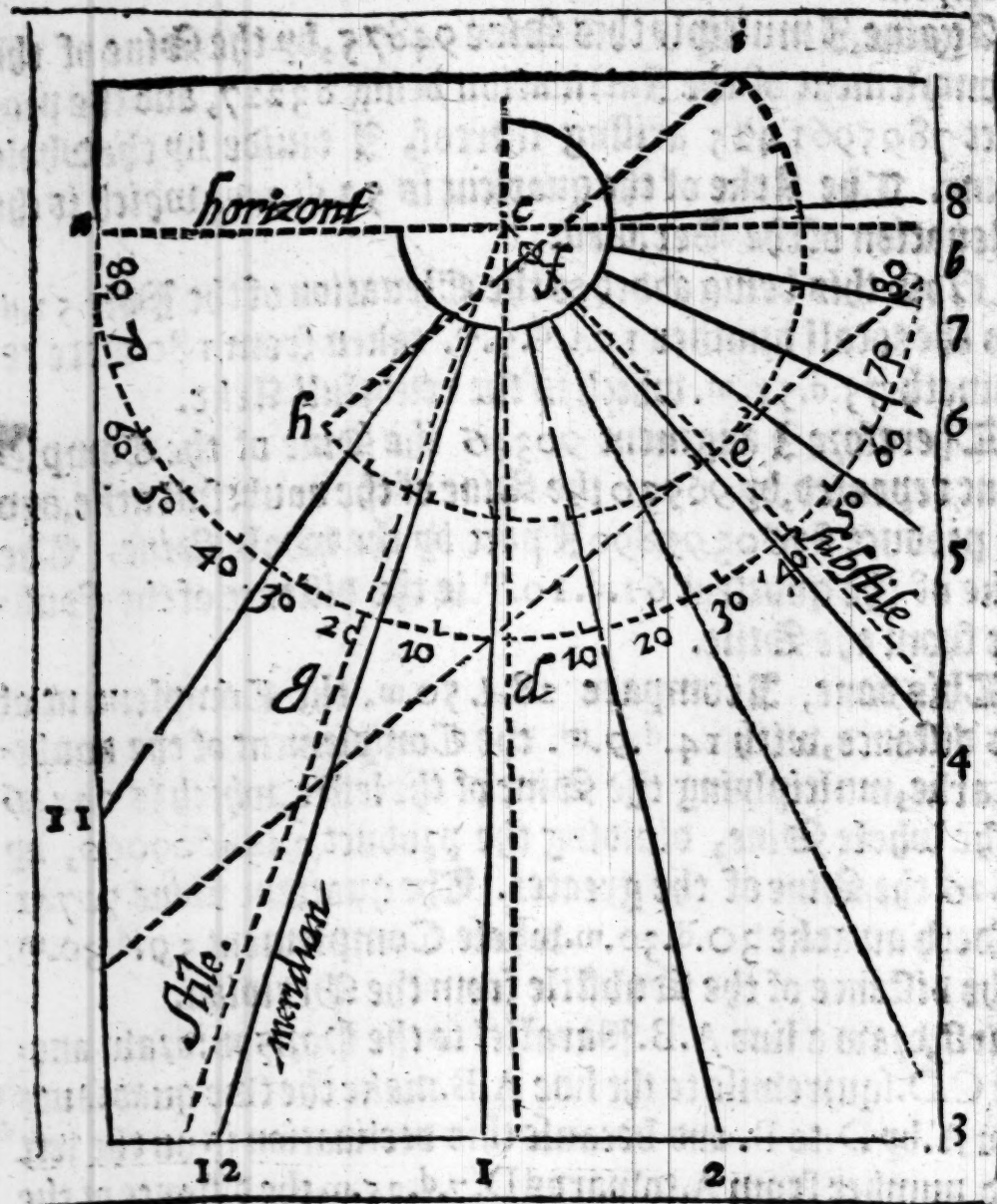
First, draw a line A.B. Parallel to the Horizon: draw another C.D. squarewise to the line A.B. make the two quadrants from A. by D. to B. and because this declination is on the left hand, number from A. towards D. 7.d. 35.m. the distance of the Meridian from the Horizon, drawing by this from C. the Meridian line. From that toward B. account 59.d. 30.m. the distance of the Substile from the Meridian, making in like manner at the end of this number from C. the Substile line E. Againe from this forward (if you can, or else backward) number the distance of the Stile from the Substile, which is 61.d. 10.m. draw likewise by this from C. the line G. for the Stile. Let the contingent cut the Substile squarewise in any place, where you wil, &c. The making of the reclining declining Dials before, shall teach you the finishing of this likewise.

The delineation of the figure.



# The Art of Dialling.

A South declining inclining.



The making of a North inclining declining Diall.

CHAP. 20.

**T**he working of this kinde is altogether like the South reclining declining Diall.

First, therefore multiply the Sine of the Declination, by the Sine of the Complement of the Inclination, dividing the product by the whole Sine. The quotient shall give an Arke: whose Complement

plement shall bee named the Complement repeated.

Then augment the Sine of the Complement of the Declination by the whole Sine, and the product part by the Sine of the Complement repeated. Whereof will come a quotient Sine: whose arke shall be the distance of that which is as it were the Meridian from the Horizon.

For the finding out of the Elevation of the Meridian, because it may bee done two sundry wayes, I will let them downe both, referring the choice to your selfe.

<p>Compare the Complement of the Arke last found out, with the Declination of the plat, multiplying the Sine of the lesser, by the whole Sine: and diuiding the product by the Sine of the greater. The quotient Sine shall yeeld an Arke whose Complement shall bee the Elevation of the Meridian.</p>	<p>Or multiply the Sine of the Arke last found out by the Sine of the Complement of the inclination, part the product by the whole Sine: and the Arke of the quotient Sine shall be the Elevation of the Meridian.</p>
---	--

Now comparing the Elevation of the Pole with the Elevation of the Meridian, subtract the lesser from the greater, retaining the number remaining, which shall bee called the difference kept.

Afterward encrease the Sine of the difference kept, by the Sine of the Complement repeated, and diuide the product by the whole Sine. The quotient arising of this diuision shall giue an Arke, which shall be the distance betweene the Style and the Substile.

To conclude, the Complement of this distance being compared with the Complement of the difference kept, multiply the Sine of the lesser by the whole Sine, and part the product by the Sine of the greater. The Complement of the Arke of the quotient Sine, shall bee the distance of the Substile from the Meridian.

But note, if the Elevation of the Meridian, and the Elevation of the Pole be found equall, make an Equinoctiall



# The Art of Dialling.

Diall, as before you were taught in the Peridionall reclining declining: for there is no difference, but onely that this is placed downeward, and the South upward.

There be of this North, as of the South reclining declining, three sundry kindes of Dials, as by the examples and figures following you may perceiue.

First Example.

Example of a North Diall { Inclining 20.d.  
Declining 30.d.

First, I multiply 50000 the Sine of the Declination, by 93969 the Sine of the Complement of the Inclination, and the product thereof 4698450000, I diuide by the whole Sine 100000, and the quotient Sine 46984 yeeldeth an Arke 28.d. 2.m. whose Complement 61.d. 58.m. is the Complement repeated.

Then I augment the Sine of the Complement of the declination, which is 86602 by the whole Sine, parting the product 8660200000, by 88267 the Sine of the Complement repeated: the quotient is 98113. The Arke thereof being 78.d. 51.m. is the distance of the Meridian from the Horizon.

Two waies in working the example, for the two precepts of the finding out the Elevation of the Meridian.

Both these tend to one end.

Now in comparing the Complement of the Arke last found out, with the declination of the plat: I find the Complement of the arke least. Wherefore I multiply the Sine thereof being 19337 by the whole Sine: and the product 1933700000, I diuide by 50000 the Sine of the greater. The quotient 38673 giueth an arke 22.d. 46.m. whose Complement 67.d. 14.m. is the Elevation of the Meridian.

Or multiply 98112 the Sine of the arke last found out, by the Sine of the Complement of the Inclination, which is 93969: and the product 9219566568 part by the whole Sine. The Quotient shall bee 92192, whose Arke 67 degrees 14 minutes is the Elevation of the Meridian.

This done, I compare the Elevation of the Meridian 67.d. 14.m. with the Elevation of the Pole 52.d. subtracting the lesser from the greater, and there remaineth 15.d. 14.m. which is the difference kept.

Then

Then I multiply 26275 the Sine of the difference kept, by 88267 the Sine of the Complement repeated: parting the product 2318455682, by the whole Sine. The Arke 11.<sup>d</sup>. 47.<sup>m</sup>. of the quotient Sine 23184, is the distance of the Stile from the Substile.

Now the Complement of this distance being 76.<sup>d</sup>. 36.<sup>m</sup>. compared with 74.<sup>d</sup>. 47.<sup>m</sup>. the Complement of the difference kept, I increase 96494 the Sine of the lesser, by the whole Sine, and the product thereof 9649400000, I distribute by 97277 the Sine of the greater. And the quotient is 99191, whole Arke is 82.<sup>d</sup>. 43.<sup>m</sup>. The Complement whereof being 7.<sup>d</sup>. 17.<sup>m</sup>. is the distance of the Substile from the Meridian.

## The delineation of the Diall.

If the Equator of the Meridian be greater than the Elevation of the Pole, draw a line A.B. parallel to the Horizon, make another C.D. square-wise to the former, describe the quadrant on the left hand from A. to C. (because the Declination is on the right hand) (numbring therein from A. upward 76.<sup>d</sup>. 32.<sup>m</sup>. the distance of the Meridian from the Horizon, draw at the end thereof from D. the line G. representing the Meridian. From this backward, toward A. account the distance of the Substile from the Meridian, which is 7.<sup>d</sup>. 41.<sup>m</sup>. making likewise at the end of this number from D. the line E. for the Substile. From hence account 11.<sup>d</sup>. 47.<sup>m</sup>. being the distance of the Stile from the Substile, drawing in like manner from D. the line F. for the Stile. Let the line of Contingence cut the Substile squarewise as before, make the Equator in this, as in the other before. Place the ruler upon the centre H. and the intersection of the Contingence line, and the Meridian, beginning the division thereof into 24. equal parts, where the ruler shall touch the Equator. Finish all things remaining, as before.

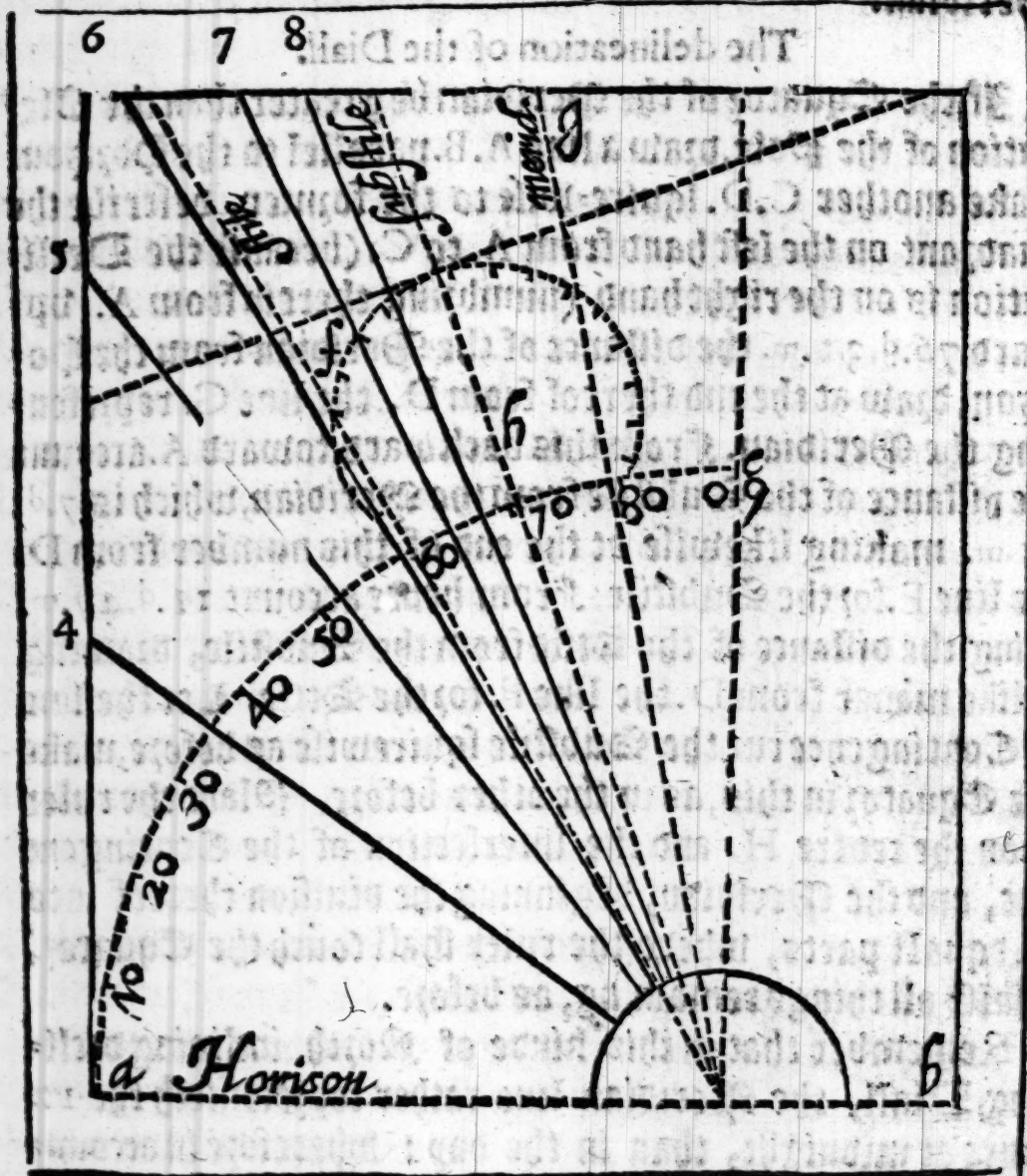
Remember that in this kinde of North inclining declining Diall, the Meridian line rather representeth the 12 houre at midnight, than in the day: wherefore in account-



# The Art of Dialling.

ting the houre lines, let the Meridian be alwaies for the 12 houre in the night. And then if your plat decline Westward, account backward as it were 11.10.9. which houres with the 12 you may omit in the delineation of your Diall, because they haue no vse in our Elevation. But account forward 8.7.6.5.4.&c. so many as you thinke shall be necessary, for some declination will receive more, than other will: the greater the more, the lesser the fewer houres. But if the declination of your plat bee Eastward, then account from the Meridian line forward 1.2.3.4.&c. so many as shall be needfull, omitting likewise the first three, &c.

A North inclining declining.

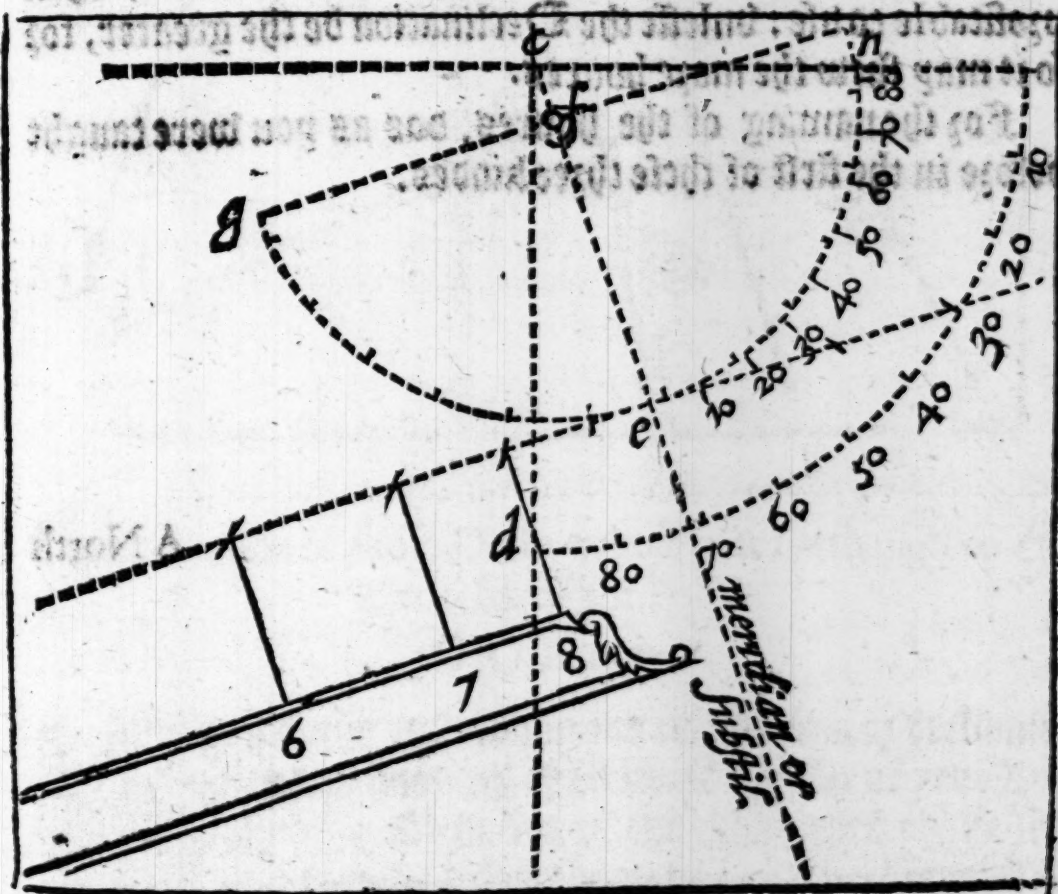


The

## The second kinde,

But if the Elevation of the Meridian, and the Elevation of the Pole be equall, the making of the Diall differeth from the other before. For an example hereof, and the drawing of the Figure, resort to the South reclining 33.d.30.m. declining 32.d. for these are both alike, onely remember here that if this decline Eastward, make the quadrant likewise on the East side, &c. But if the plat decline toward the West, make the quadrant Westward (as in the Figure following) finishing all things else as her you see done. Observe the same order in naming the houre lines which I taught you before.

## A North inclining declining.





# The Art of Dialling.

The third Example of a  $\left\{ \begin{array}{l} \text{Inclining } 45.d. \\ \text{Declining } 45.d. \end{array} \right.$   
North Diall.

If the Elevation of the Meridian be lesser than the Elevation of the Pole, make your Diall thus.

For the working of the example, and the delineation of the Figure, resort to the South reclining  $45.d.$  declining  $45.d.$  for that agreeth with this, except onely that in this, the Stile is placed downward, and sheweth but few houres, and those likewise are drawne downward: but in the other the Stile standeth upward, shewing many houres, and those likewise for the most part are drawne upward. Marke also in this kinde, if your plat decline Westward, draw the quadrant on the Westside, but if the Declination be Eastward, make the Quadrant on the Eastside, &c.

The making of these, are more pleasant to know, than profitable to vse: unless the Declination be the greater, for so it may shew the more houres.

For the naming of the houres, doe as you were taught before in the first of these three kindes.

A North







# The Art of Dialling.

Commonly these following be such as here we meane.

A South { Reclining direct.  
Declining erect,  
Declining reclining.

An East or West { Reclining.  
Inclining.

A North { Inclining direct.  
Declining erect.  
Declining inclining.

In all these kindes oftentimes the distance betweene the Stile and the Substile is so small, that it is not possible to draw your Diall, except the plat be very large: which at all times you shall not haue.

Therefore the best way is this. First, draw your Diall very true (as before hath beene taught) vpon a large paper, making your quadrant so great as may be. Draw likewise the houre lines very long, which will cause the greater distance betweene the Stile and the Substile, and in like maner betweene the houre lines. It will also procure the greater Equator, which will be a great helpe in the drawing of your Diall, as by the Figure following you may perceiue.

When you haue thus drawne your Diall, then at the end of the paper where the lines be of greatest distance, draw the line I.K. parallel to the Horizontall line, make likewise the other line L.M. (according to the greatnesse of your plat) of equall distance from the other. This done, fince out (or rather draw a line vpon your plat which may represent) the true Horizon of the plat: cutting the paper in sunder by the line I.K. and the line L.M. placing it vpon your plat very plain, so that one of the edges may be parallel to the Horizon. Then make markes vpon the plat at both ends of all the houre lines, drawing by those markes, the lines for the houres. Draw likewise light lines vpon the plat for the Stile and the Substile, easily to be distinguished, as you did vpon the paper.

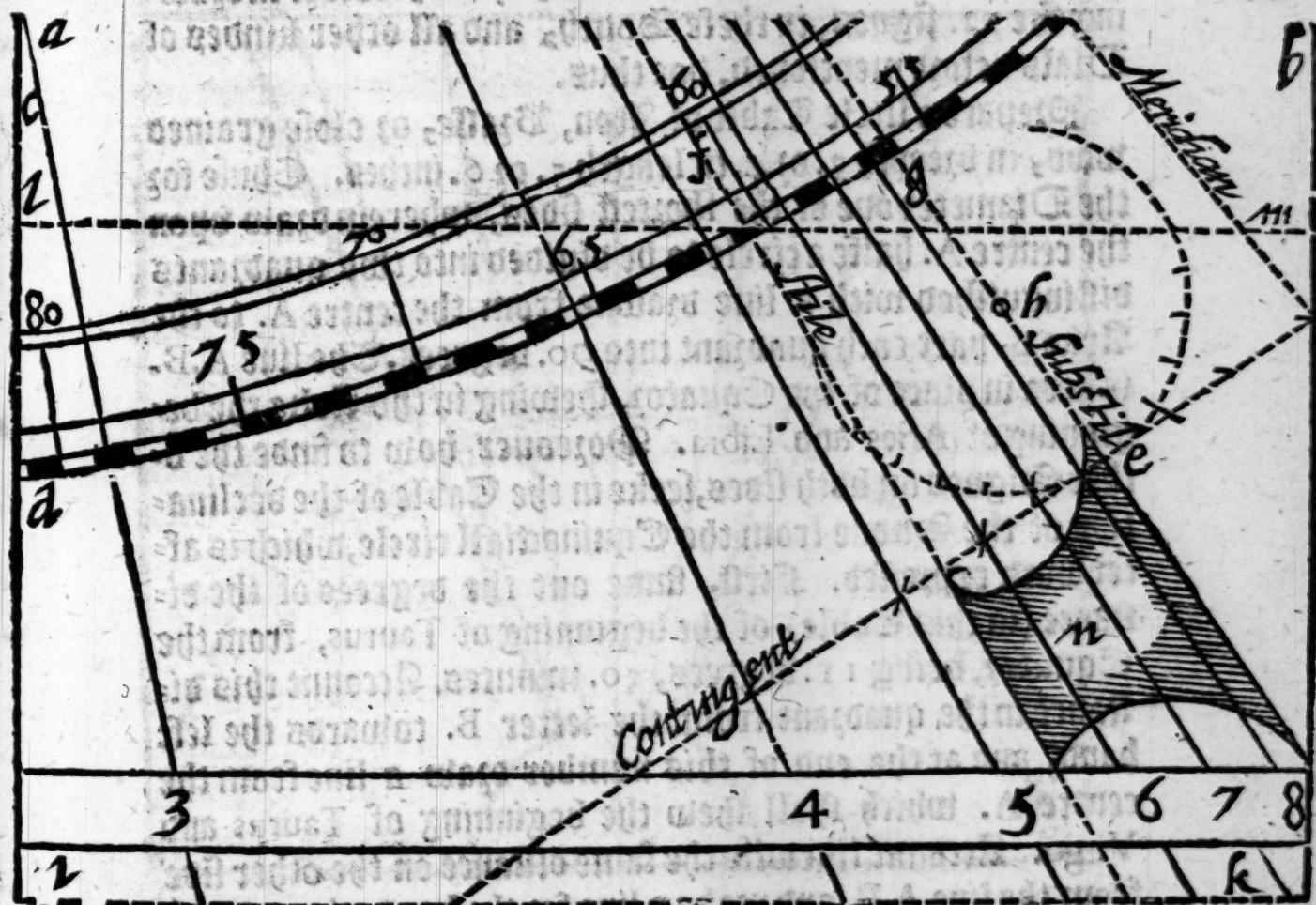
Let the Stile N. be fastened ouer the Substile, as you haue been

been taught in the East, and West, of Equinoctiall Dials.

But here note, that the Stile must not be of equall height at both ends. But let it be so high, as the distance betweene the Stile and the Substile is in the place where it standeth, as in the examples following you may plainly perceiue.

## A North Diall.

Declining Westward	65 d.
Inclining	22. d. 20. m.
Distance of the Meridian from the Horizon	30. d. 50. m.
Distance of the Substile and the Meridian	6. d. 35. m.
Distance of the Stile and Substile	4. d. 15. m.
Elevation of the Pole	52. d.



Hitherto wee haue taught the delineation of all kindes of Dials, which are to bee made vpon any plaine plat or superficies: now followeth the garnishing of them, with the 12. Signes, and the houres vnequall.



# The Art of Dialling.

How to draw the 12. Signes in all kindes of Dials  
before mentioned.

## CHAP. 22.

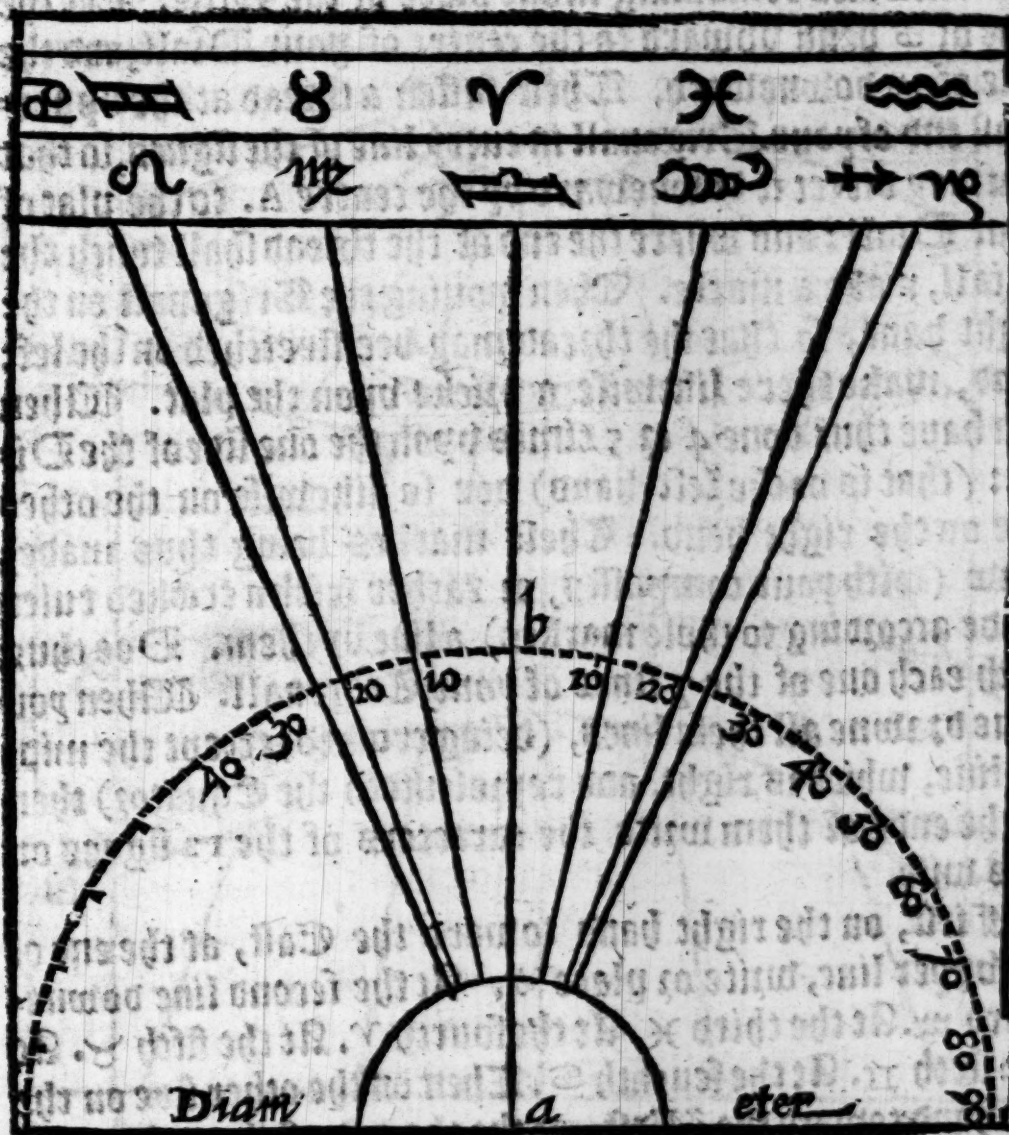


As much as sometime the 12 signes of the Zodiacke are placed in Sunne Dials, to know in what signe the Sunne is at any time (which albeit any kinde will receiue, yet most commonly the verticall directly opposite to the South are garnished therewith:) Therefore in drawing the 12. signes, in these South, and all other kindes of Dials before mentioned, doe thus.

Prepare a little Table of Iron, Brasse, or close grained wood, in breadth 3. or 4. in length 5. or 6. inches. Chuse for the Diameter one of the shortest sides, wherein draw upon the centre A. halfe a circle to be diuided into two quadrants distinguished with a line drawne from the centre A. to the Arke B. part each quadrant into 90. degrees. The line A.B. is here in place of the Equator, shewing in the Arke the beginning of Aries and Libra. Moreover how to finde the other Signes on both sides, seeke in the Table of the declination of the Sunne from the Equinoctiall circle, which is afterward expressed. First, finde out the degrees of the distance (in this Table) of the beginning of Taurus, from the Equator, being 11. degrees, 30. minutes. Account this distance in the quadrant from the letter B. towards the left hand, and at the end of this number draw a line from the centre A. which shall shew the beginning of Taurus and Virgo. Account likewise the same distance on the other side from the line A.B. and make a line for the beginning of Pisces and Scorpius. Again in the 20.<sup>d</sup>. 12.<sup>m</sup>. from the line A.B. you shall haue the beginning of Gemini and Leo: and so many degrees and minutes on the other side, the beginning of

of Aquarius and Sagittarius. To conclude on both sides in the 23. degrees 30. minutes, there must be on the one part Cancer, and on the other Capricorne.

Afterward draw lines from the centre A. by every marke so long as your Table will receive: and at the end of these lines let the characters of the 12. signes of the Zodiacke bee fixed: as in the figure following you may see.





# The Art of Dialling.

The vse of this Trigonall Instrument, in writing  
the 12. Signes in Dials.

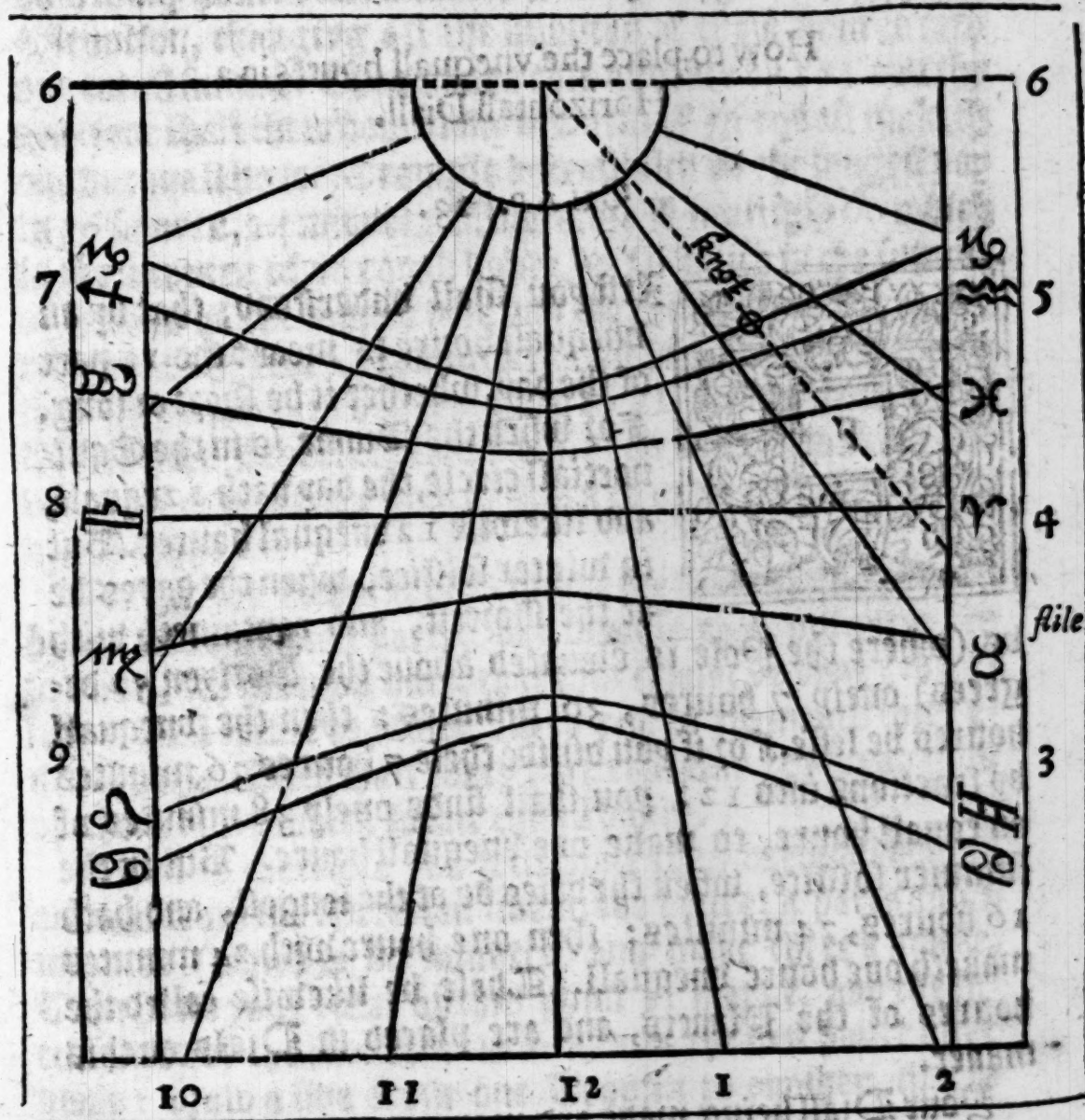
**Y**our Diall being made, and the Stile placed therein:  
Take your Trigonall Instrument, and set it vpon the  
Stile, so that the whole Diameter thereof may stand plaine  
vpon the edge or vpper part, the centre A. of your Instru-  
ment alwaies remaining in one place of the Stile. Let the  
line of  $\odot$  bend vppward to the centre of your Diall, and the  
line of  $\gamma$  downeward. Then fasten a thread at the vpper-  
most end of your Trigonall in every line of the signes, so that  
you may direct it downeward by the centre A. to the plat of  
your Diall: and where the end of the thread shall touch the  
Diall, make a marke. Then mouing the Trigonall on the  
right hand, so that the thread may bee stretched on the left  
hand, make there likewise a picke vpon the plat. When  
you haue thus done 4 or 5 times vpon the one side of the Di-  
all: (that is on the left hand) doe so likewise on the other  
side on the right hand. These markes being thus made,  
draw (with your compasses, or rather with a crooked ruler  
made according to those markes) a line by them. Doe thus  
with each one of the 7 lines of your Trigonall. When you  
haue drawne all these lines, (being crooked, except the mid-  
dle line, which is right, and representeth the Equator) then  
at the ends of them write the characters of the 12 signes on  
this wise.

First, on the right hand toward the East, at the end of  
the vpper line, write or place  $\gamma$ . At the second line downe-  
ward  $\times$ . At the third  $\times$ . At the fourth  $\gamma$ . At the fifth  $\gamma$ . At  
the sixth  $\Pi$ . At the seventh  $\odot$ . Then on the other side on the  
left hand toward the West, at the the end of the nethermost  
line place  $\odot$ . At the second  $\Omega$ . At the third  $\Pi$ . At the fourth  
 $\Pi$ . At the fifth  $\Pi$ . At the sixth  $\gamma$ . And finally againe at the  
vppermost set  $\gamma$ .

This done, remember that in what place of the Stile the  
centre

# The Art of Dialling. 40

centre A. of your Trigonall was placed, there fasten a small piece of yron or any such like thing, which may shew with the shadow thereof, the Signe which the Sunne shall bee in at any time: vnlesse the houre lines bee so short, that where the small piece of yron should bee placed, you may cut the Scile that the end thereof shall shew it. But the first is the most conuenient way for the vse thereof.



You may in like manner with this Instrument draw or place the 12 signes in Horizontall, East, West, and all other kindes of Dials, which before are recited: because the difference



# The Art of Dialling.

difference is nothing but in placing the 12 signes at the ends of the lines: the true doing whereof, you may easily perceive by the course of the Sunne. For in the South Erect, when the Sunne occupieth Cancer, then is the line of  $\odot$  furthest distant from the center of the Diall. But in the Horizontall Diall, the line of  $\odot$  is next to the centre. Few words shall suffice for this matter: experience shall easily teach you herein.

How to place the vnequall houres in a Horizontall Diall.

CHAP. 23.



First you shall vnderstand, that by an vnequall houre is meant the 12 part of the day, whether it be short or long. For when the Sunne is in the Equinoctiall circle, the day hath 12 equall, and likewise 12 vnequall houres. But in winter solstice, when the dayes be at the shortest, and containeth with vs (where the Pole is elevated aboue the Horizon 52 degrees) onely 7 houres, 36 minutes: then the vnequall houres be lesse. For if you diuide these 7 houres 36 minutes by fractions into 12: you shall finde onely 38 minutes of an equall houre, to make one vnequall houre. But in the summer solstice, when the daies be at the longest, and hath 16 houres, 24 minutes: then one houre with 24 minutes maketh one houre vnequall. These be likewise called the houres of the Planets, and are placed in Dials on this manner.

Your Diall being made and prepared, draw vpon it the 12 signes of the Zodiacke (as you were taught before) so large as your plat will giue leaue, &c.

Note that alwaies the Meridian line, or 12 equall houre

is the 6 vnequall houre. Marke likewise, that when the Sunne entreteth into the beginning of  $\gamma$  and  $\pi$ , both the equall and vnequall houres be of like quantity. For the 7 equall houre in the morning is the first vnequall, and the 8 equall the 2 planetare houre, &c.

But in the Tropike of  $\odot$  it is otherwise: for then the vnequall houres be greater than the equall. Therefore account how many houres and minutes is in the longest day for your Elevation, changing all the minutes of those houres into one totall summe. Then diuide this number by 12: and the quotient shall shew how many minutes of an equall maketh one vnequall houre. Example hereof: with vs the longest day is 16 houres, 24 minutes. Wherefore I multiply 60 which is the minutes of an equall houre, by 16 which is the summe of houres of the longest day, and the product ariseth to 960, whereto I adde 24 minutes remaining, then the number shall be 984, which being diuided by 12, the quotient is 82. Wherefore I conclude that 82.m. of an equall, maketh one vnequall or planetare houre. Then to draw them in Dials, worke thus.

First, in the Tropike of  $\odot$  diuide the space betwene each houre into 60 equall parts, but because those distances bee so small, for the most part, that this cannot be done: therefore it shall suffice to diuide euery one of them into three equall parts. Then shall euery part containe 20.m. and three of them 60.m. which is one equall houre.

When as therefore you will place the 7 vnequall houre, account from the Meridian line, or the houre, 4 parts and 2 minutes (which is 82 minutes) and make there a marke. Then place your ruler by this point or marke, and the intersection of the line of  $\gamma$  and  $\pi$ , and the first houre after noone: draw a line from one Tropike to another, that is from  $\odot$  to  $\psi$ .

Then for the placing of the 8 vnequall houre, account from the 7 last made, 4 of the foresaid parts and two minutes; make there a marke, by which and the intersection of the



# The Art of Dialling.

the line of  $\vee$  and  $\equiv$  and the line of the second houre after-  
none, the ruler being placed, draw a line, as before.

For the 9 account from the 8 last made, likewise 4 parts  
and two minutes, drawing a line as before. Doe in like  
maner for the drawing of all the other remaining: that is,  
for the 10 and 11. The 12 being the Sunne setting, shall  
neede no line.

As you haue finished the vnequall houres on this side for  
the afternone, doe in like maner for those in the forenone:  
accounting from the Meridian 4 parts and 2.m. of an equall  
houre, to each vnequall, drawing, as before, lines from one  
Tropicke to another.

You may place the figures for the vnequall or planetrate  
houres, at the end of the lines vnder the Tropicke of Capri-  
corne, or aboue the line of Cancer as you will.

Note that the same part of the Stile which sheweth the  
12 signes, shall likewise shew the vnequall houres. For  
better vnderstanding hereof:

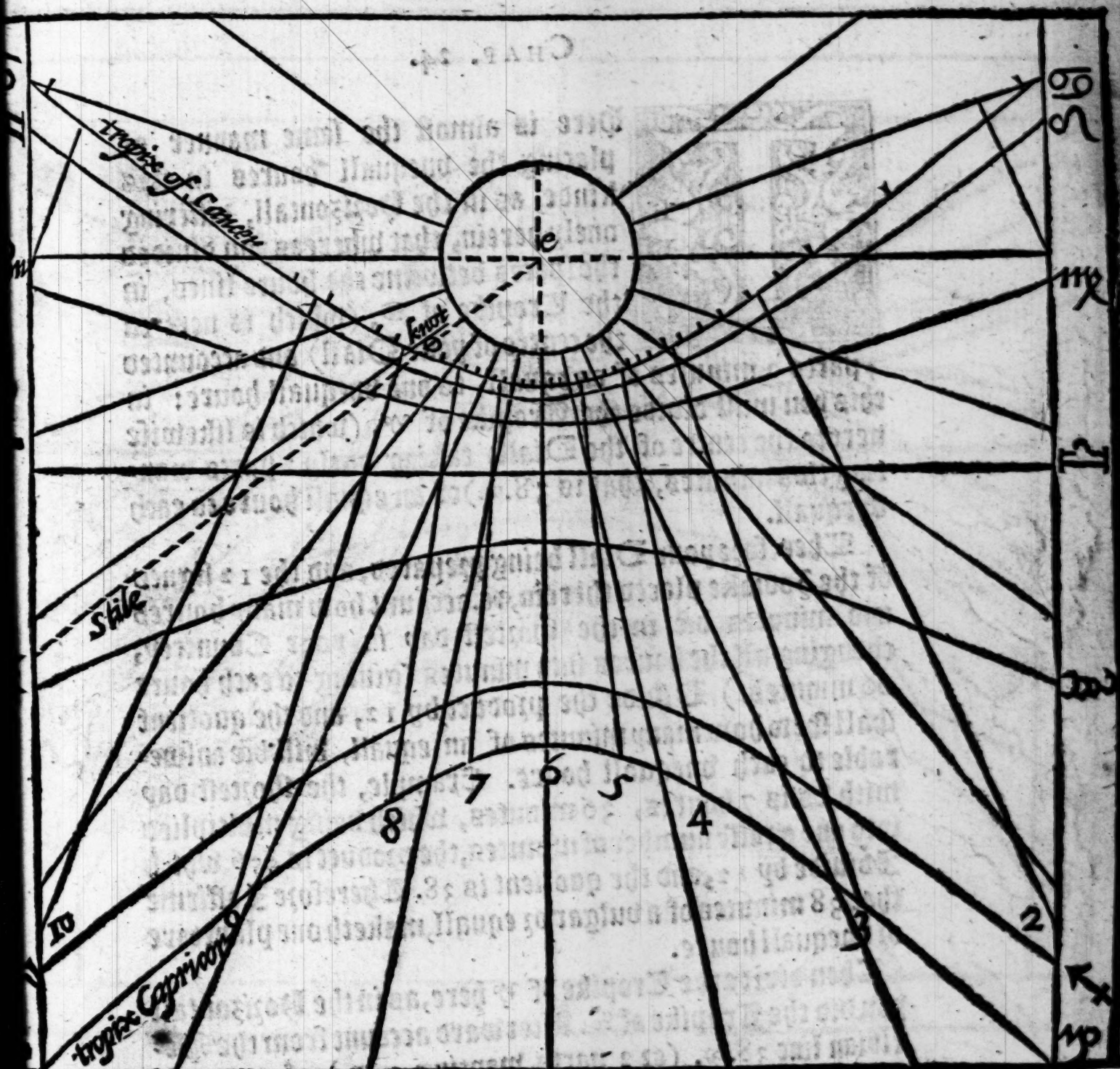
Behold the Figure following.

A Hor-

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## An Horizontall Diall.



How to erect a Diall in any position, and to find the hour of the day by the shadow of the gnomon. A South



# The Art of Dialling.

How to place the houres vnequall in a South  
erect direct Diall.

## CHAP. 24.



Here is almost the same manner of placing the vnequall houres in this kinde, as in the Horizontall, differing onely herein, that whereas you diuided the spaces betwene the houre lines, in the Tropike of  $\odot$ , (which is next to the centre of your Diall) and accounted 4 parts 2 minutes of an equall, to one vnequall houre: in this you must diuide the Tropike of  $\omega$ , (which is likewise next to the centre of the Diall) taking onely 2 parts wanting two minutes, (that is 38.m.) of an equall houre to each vnequall.

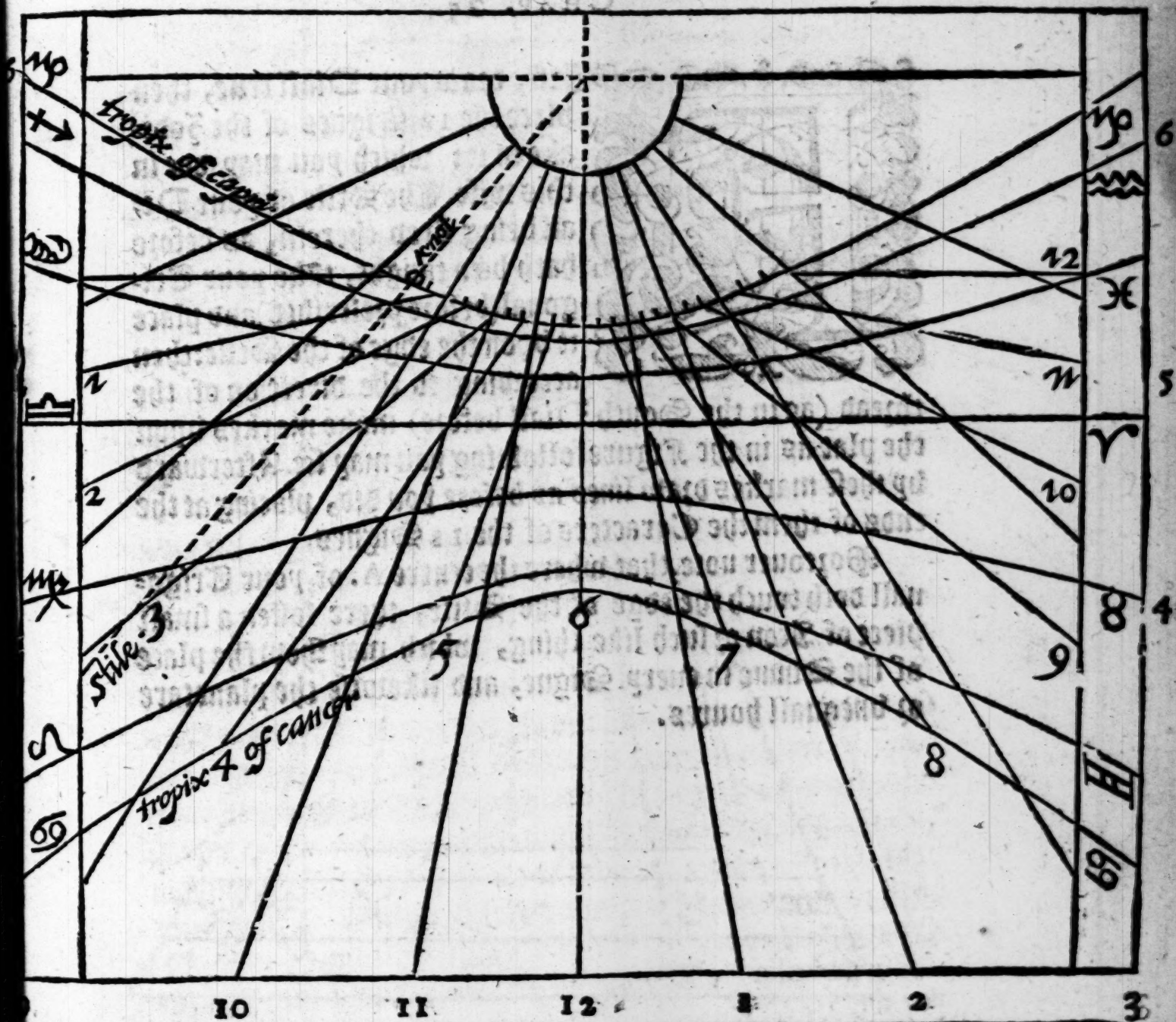
Therefore your Diall being prepared, and the 12 signes of the Zodiacke placed therein, &c. account how many houres and minutes bee in the shortest day in your Countrey, changing all the houres into minutes (giuing to each houre 60 minutes.) Diuide the product by 12, and the quotient shall shew how many minutes of an equall, will bee answerable to each vnequall houre. Example, the shortest day with vs is 7 houres, 36 minutes, which being multiplied into one grosse number of minutes, the product is 456, which I diuide by 12, and the quotient is 38. Therefore I affirme that 38 minutes of a bulgar or equall, maketh one planetare or vnequall houre.

Then diuide the Tropike of  $\omega$  here, as in the Horizontall you did the Tropike of  $\odot$ . Afterward account from the Meridian line 38.m. (or 2 parts wanting 2.m.) of an equall houre to each vnequall, &c.

Finish all things else in this Pericionall erect direct, as you were taught in the Horizontall. The Figure ensueth.

A South

## A South Diall.





# The Art of Dialling.

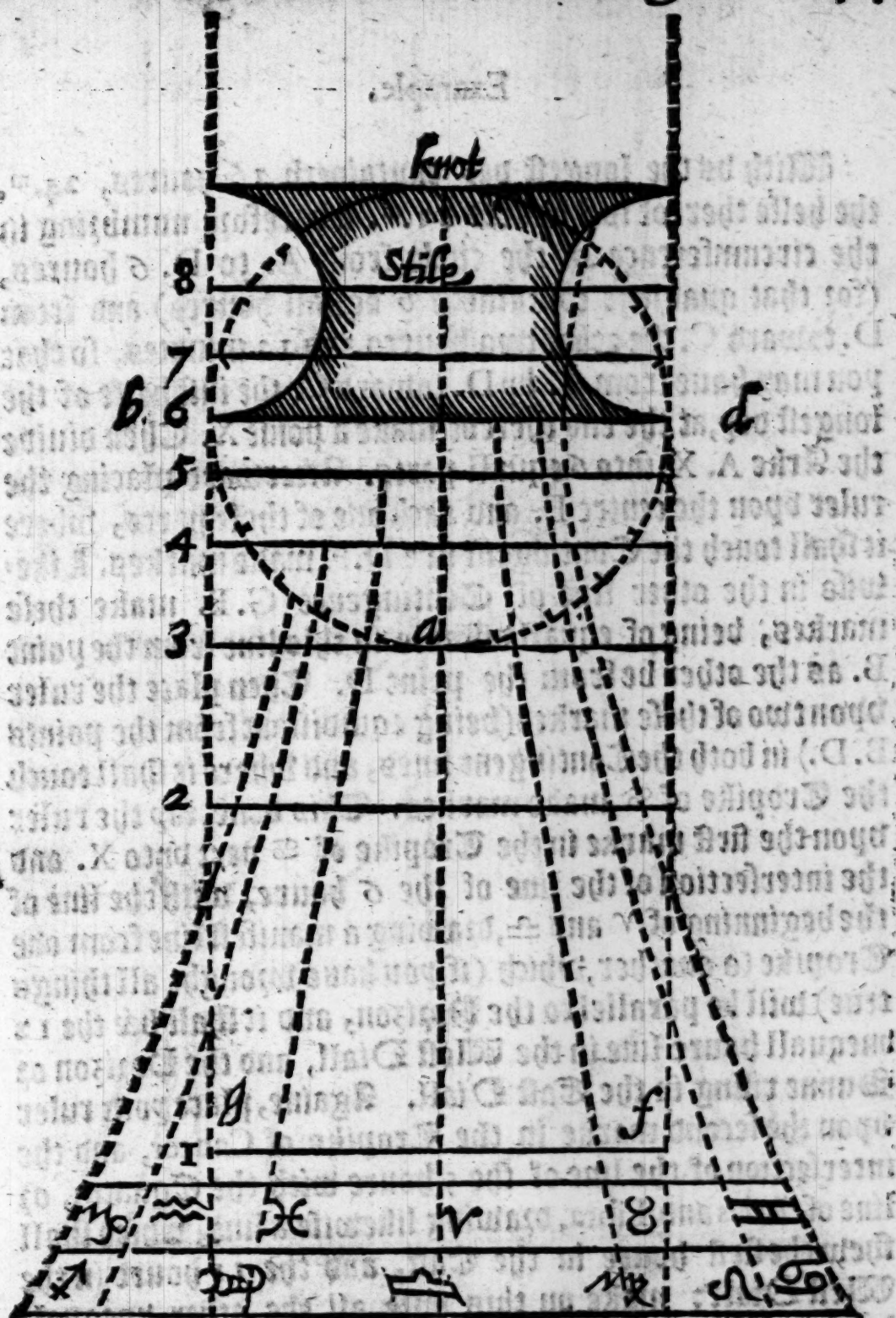
The placing of the houres vnequall in East  
and West Dials.

## CHAP. 25.



First, draw your Diall true, then place the 12 Signes of the Zodiacke in it: which you may doe in this wise. The Stile of your Diall being fixed therein, as before hath been taught, take your Trigonal (before prescribed) and place it vpon the edge of the Stile: then according to the direction of the thread (as in the South Diall before) make markes vpon the plat as in the Figure following you may see. Afterward by these markes draw lines as before you did, placing at the ends of them the Characters of the 12 Signes.

Moreouer note, that where the centre A. of your Trigonal doth touch the edge of the Stile, there fasten a small piece of Iron or such like thing, which may shew the place of the Sunne in euery Signe, and likewise the planetare or vnequall houres.



When as therefore you would place the houres unequal in those kinds of Dials, account the number of houres and minutes, which the halfe of the longest day in your Country both containe.

Example



# The Art of Dialling.

## Example.

With vs the longest day containeth 16 houres, 24.<sup>m</sup>. the helpe thereof is 8 houres 12.<sup>m</sup>. wherefore numbring in the circumference of the circle from A. to D. 6 houres, (for that quadrant containeth 6 equall houres) and from D. toward C. the other two houres and 12 minutes, so that you may haue from A. by D. toward C. the iust halfe of the longest day, at the end thereof make a point X. Then diuide the Arke A. X. into 6 equall parts. Afterward placing the ruler vpon the centre E. and each one of these parts, where it shall touch the Contingent line D.F. make markes. Likewise in the other line of Contingence G.B. make these markes, being of equall distance in this line from the point B. as the other be from the point D. Then place the ruler vpon two of these markes (being equidistant from the points B. D.) in both the Contingent lines, and where it shall touch the Tropike of  $\varnothing$ , make markes. This done, lay the ruler vpon the first marke in the Tropike of  $\varnothing$  next vnto X. and the intersection of the line of the 6 houre, with the line of the beginning of  $\gamma$  and  $\varnothing$ , drawing a manifest line from one Tropike to another, which (if you haue wrought all things true) will be parallel to the Horizon, and it shall bee the 12 vnequall houre line in the West Diall, and the Horizon of Sunne rising in the East Diall. Againe, place your ruler vpon the second marke in the Tropike of Cancer, and the intersection of the line of the 5 houre with the Equator, or line of Aries and Libra, drawing likewise a line, which shall shew the first houre in the East, and the 11 houre in the West Diall: make on this wise all the other vnequall houres, namely the 10, 9, 8, and 7, in the West Diall. And the 2, 3, 4, 5, in the East Diall.





# The Art of Dialling.

The making of an Horizontall Sphericall,  
or hollow Diall.

CHAP. 26.



First, prepare your Sphere or plat perfectly hollow, of what quantity you will: then with your compasses divide the upper brym thereof, into 4 equall parts, marking it with the letters A.B.C.D. Afterward upon your Compasses to the widenesse of one Quadrant, either A.C. or A.D. and with that widenesse, one foote being placed in the point D. draw an obscure or light line from A. to B. This done, set one foote of your Compasses in the point C. and with the other your shall try whether the plat be perfectly Sphericall or not: for if it be, your Compasses will fall in the same line which you made before, but if it be not perfect, you may amend it. And then draw this line manifest, so that it may continue. For it shall be the Meridian line, shewing the 12 houre. Again, place one foote in the point A. drawing with the other a light line from C. to D. then one foote being set in B. you may try with the other, as before, the truth of the line last made. Now where these two lines cut each other in the bottome of the plat, place the letter E. Then dividing the quadrant A.E. into 90.<sup>d</sup>. and accounting therein the Elevation of the Pole from E. toward A. make the point F. by which the arke line of  $\gamma$  and  $\pi$ , representing the Equinoctiall circle, shall be drawne. Afterward seeke out the greatest declination of the Sunne from the Equator, (which you shall finde in the table of the declination of the Sun) which is 23.<sup>d</sup>. 30.<sup>m</sup>. Then account 23.<sup>d</sup>. 30.<sup>m</sup>. from F, toward E. making there a marke for the Arke of Cancer. Likewise from F. toward A. number the same distance, for the Arke line of Capricorn. This done, account from F. toward E. 20.<sup>d</sup>. 12.<sup>m</sup>. make there also a mark  
for

for the line of  $\Pi$  and  $\Omega$ . And the like space from F. towards A. for the Arke of  $\alpha$  and  $\tau$ . To conclude, runther from F. towards E. 11. d. 30.<sup>m</sup>. making there also a marke for the line of  $\gamma$  and  $m$ : and so much from F. toward A. for  $\chi$  and  $n$ .

When you haue thus made markes for all the Arkes of the 12 Signes, open your Compasses to the Quadrant of the Sphere, that is, from A. to C. which widenesse of the Compasses remaining, place one foote in the point F. in the Arke of  $\nu$  and  $\equiv$  in the Meridian: and where the other foot shall touch the same Meridian towards B. make the point G. which shall represent the Pole antarctike, by which, as it were from a centre, draw a line from the point D. by F. to C. which shall be the line of Aries and Libra. Then one foote of your Compasses remaining in the point G. with the other draw lines from one side of the plat to the other, by euery marke before made for the 12 Signes of the Zodiacke.

The 12 Signes being thus finished, proceede to the diuision of the equall houres on this maner. Diuide the Arke of the Equator into 12 equall parts, beginning at D. by F. ending in C. Then open your Compasses to the quadrant of the plat, and the same widenesse of them remaining, place one foote on the first point of the diuision next C. in the Equator, and if you haue diuided the Equator equally, the other foote will touch the first part beyond F. towards D. by which from the centre G. to the edge of the plat, draw a line, which shall shew the first houre afternoone. This done, remoue your Compasses (that widenesse remaining) placing one foote in the second part from C. towards F. and the other foote touching the second part from F. towards D. make a line as before, from the centre G. to the brimme of the plat, to shew the 2 houre afternoone. In like manner, finish all the other houre lines, namely, the 3, 4, 5, 6, 7, 8, for the afternoone. Then doe likewise on the other side for the houres in the forenoone, namely, the 11, 10, 9, 8, 7, 6, 5, and 4, drawing lines from the centre G. by euery diuision, to the brimme of the plat, &c.



# The Art of Dialling.

The placing of the vnequall houres in this Diall.

When you will place the houres vnequall in this Sphericall Diall, diuide the Tropike of Cancer and Capricorne each of them into 12 equall parts, as befoze you did the Equator for the equall houres. Then with the Compasses ioyne each thzee points of these thzee Arkes, answerable into one line of Arke, untill you haue made 12 lines to shew the 12 vnequall houres, as in the Figure following you may see. Whereof the Meridian, of 12 vnequall houres shall alwaies be the 6 vnequall houre.

In placing the figures to the equall and vnequall houres, and the Characters to the 12 Signes of the Zodiacke, the figure may sufficiently shew, notwithstanding you may place them where you will giuing to each signe his proper Character, and euery houre equall and vnequall their proper figures or names.

Fixe the Stile in the centre G. standing vp so high as the hümme of the plat, so that the vpper end may appeare as the centre of the circumference, which you may try, by placing a ruler vpon the points A. B. And againe vpon C. D. In like maner you may examine it with your Compasses, but the former, as practice will teach you, is the moze conuenient way.

You may, if you will, haue the Stile stand aboue the plat, so that it may shew the equall houres aboue the edge of the Sphere, and then fasten a knot of equall height with the plat, which shall shew the motion of the Sunne in the 12 Signes and the vnequall houres, which otherwise the end of the Stile should doe: as in the Figure following you may perceiue.





# The Art of Dialling.

The making of a South Sphericall erect direct Diall.

CHAP. 27.



**Y**ou shall vnderstand, that the making of this kind differeth almost nothing from the Horizontall: except onely in the accounting the beginning of the Elevation of the Pole, and drawing the houres vnequall.

First, your Sphere or plat being prepared, and parted into foure Quadrants, as before in the Horizontall you were taught, diuide the Quadrant E.A. into 90 degrees. Then number in it the Elevation of the Pole from A. toward E. marking the end of the number with F. Afterward open your Compasses to the quadrant of the plat, and the one foot placed in F. extend the other in the Meridian line towards B. making the point G. where it shall touch the Meridian line: from which point as a centre you shall draw the lines for the 12 Signes, as you were taught in the Horizontall. Diuide likewise, and draw the lines for the equall houres, as before in the Horizontall.

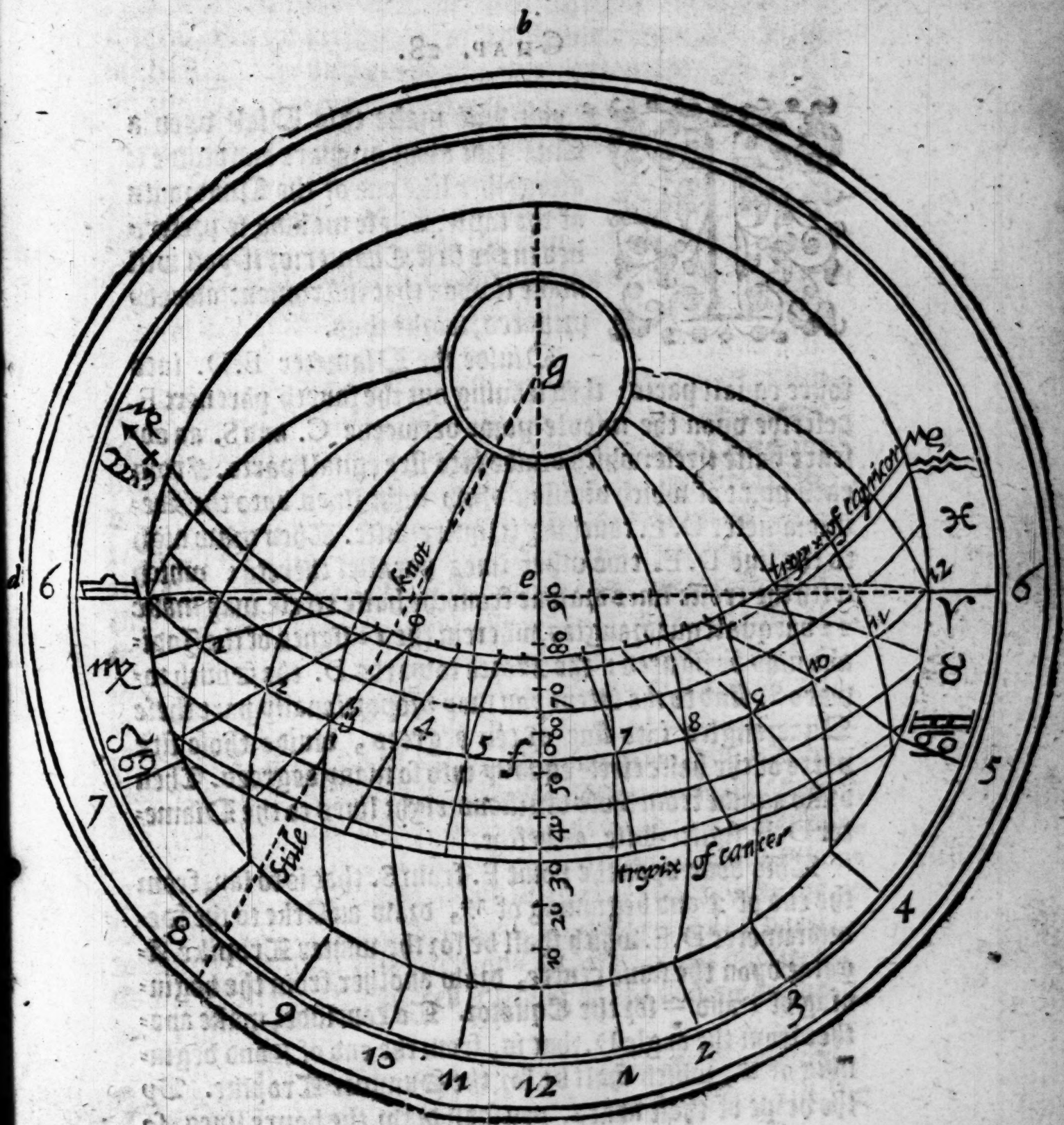
The placing of the houres vnequall in this kinde is done as in the South Erect Direct vpon a plaine superficies, except onely that whereas there you did draw them with a ruler, here you shall doe it with Compasses on this maner. Open your Compasses to the Quadrant of the plat, that is, from A. to C. accounting from the Meridian in the Tropike of Capricorne, two parts wanting two minutes of an equall houre, making there a marke: And that widenesse of your Compasses remaining, draw a line from that marke made in the Tropike  $\Psi$ , by the intersection of the line of Aries and Libra, and the line of the first houre in the afternoone, vnto the Tropike of Cancer. Draw all the other lines for the vnequall houres in like maner, as in the Figure you may plainely see.

Fixe the Stile in the centre G. as you did in the Horizontall, placing the figures for the equall and vnequall houres, and

# The Art of Dialling.

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and the Characters to the 12 Signes, as in the example following, or otherwise as you will.





# The Art of Dialling.

The making of a Diall vpon a Quadrant, or the Table described in the beginning of the Booke.

## CHAP. 28.



If you will make this Diall vpon a Quadrant alone, prepare and diuide it altogether like one of the Quadrants of the table, whose making is prescribed in the first Chapter: or if you will make it vpon that instrument already prepared, worke thus.

Diuide the Diameter E.D. into foure equall parts; then leauing out the fourth part next E. describe vpon the middle point betweene C. and S. an obscure halfe circle: which diuide into sixe equall parts. From each point of which diuision draw light lines vnto the Semidiameter D.E. touching it squire-wise. Then draw nigh to the line D.E. two other lines parallel thereto: which with the crosse lines drawne from the halfe circle, may make 12 vnequall quadzangles, wherein the 12 signes of the Zodiacke may be figured: the North towards D. the South toward S. And to the intent you may proportionally part these Quadzangles into sixe or ten degrees, diuide those sixe parts of the halfe circle equally into so many degrees. Then draw againe from those diuisions right lines to the Diameter D.E. squire-wise, as before.

This done vpon the point E. from S. that is to say, from the end of ♄ and beginning of ♊, draw an Arke to the Semidiameter D.E. which shall be for the winter Tropike. Againe vpon the same centre, draw another from the beginning of ♊ and ♋ for the Equator. To conclude, make another from the angle D. that is, from the end of ♊ and beginning of ♋, which shall be for the Summer Tropike. By the helpe of these arkes, you shall draw the houre lines, so that

that you first know the height of the Sunne above the Horizon, at every houre, when it occupieth the beginning of  $\gamma$ ,  $\nu$ , and  $\delta$ . Whose altitude is thus found out.

Take the Elevation of the Pole, and the Complement thereof, also the declination of the Sunne from the Equinoctiall, and the distance of the Sunne from the Meridian, accounting 15 degrees for every houre, with the Complement of this distance. Then if you desire to know the altitude of the Sunne at sixe of the clocke either in the morning or at evening (at which houre onely in Summer it is above the Horizon) multiply the Sine of the Elevation of the Pole, by the Sine of the declination of the Sunne, dividing the product by the whole Sine, and you shall have your desire.

But if the Sunne shall be distant from the Meridian fewer houres than sixe, multiply the Sine of this distance (giving to every houre 15 degrees) by the Sine of the complement of the altitude of the Pole, and the product hereof divide by the whole Sine. Then take the Arke of the quotient from 90 degrees, and the first number found out shall remaine, which must bee kept. Then compare the Sine of this number found out, with the Sine of the Elevation of the Pole, augment the lesser by the whole Sine, dividing the product by the greater: whereof shall come a quotient Sine, to the Complement of whose Arke adde the declination of the Sunne, if it shall be in the North signes, or subtract it from that, if it occupieth the South signes. And if the number which cometh hereof shall be greater than 90, take it from 180, and you shall have the second number found out. The Sine of this number found out being multiplied, by the Sine of the first number found out, shall yeeld a product, which part by the whole Sine, and the Arke of the quotient Sine, shall shew the desired altitude of the Sunne for the houre propounded.

But if the distance of the Sunne from the Meridian shall exceede sixe houres (that is 90 degrees) take the de-



# The Art of Dialling.

degrees of that distance from 180, multiplying the Sine of the remainder by the Sine of the Complement of the altitude of the Pole, dividing the product by the whole Sine, and subtract the Arke of the Quotient from 90, the remainder shall be called, the first number found out. The Sine of which number found out, compared with the Sine of the Elevation of the Pole, increase the lesser by the whole Sine, and distribute the product by the greater. Then take the Complement of the Declination of the Sun, from the Arke of the quotient, and you shall have the second number found out.

Finally, the Sine of the first number found out, and the Sine of the second being multiplied by themselves, and the product parted by the whole Sine; the quotient Sine shall yeeld an Arke, which shall be the altitude of the Sunne.

But when the Sunne occupieth the beginning of  $\gamma$  or  $\delta$ , you shall finde the altitude thereof every houre, onely by multiplying the Sine of the Complement of the distance of the Sunne from the Meridian, by the Sine of the Complement of the Elevation of the Pole, dividing the product by the whole Sine, the quotient which commeth hereof shall yeeld the Arke of your desire. At both the six houres, because the one side is the rising, and the other the setting, there is then no altitude of the Sunne above the Horizon.

Moreover, to know how much the Meridian altitude is, of the Sunne entering into  $\delta$ , add the greatest Declination thereof, to the Complement of the Elevation of the Pole: and by subtracting the greatest Declination of the Sunne, from the Complement of the Elevation of the Pole, you shall likewise have the Meridian altitude of the Sunne entering into  $\delta$ .

You shall likewise seek the height of the Sunne, being in the 10 degree of  $\gamma$  above the Horizon, at 8 of the clocke before none, and at 4 after none at 7 in the morning, and 5 in

in the evening: at both 6 and the 5 houre in the morning, and 7 at night. Also at 5 in the morning and 7 in the evening, the Sunne being in the beginning of  $\Pi$ .

But because the working of this, to finde out these altitudes, requireth much time and labour, wee will set downe these distances ready found out, calculated for the Elevation of the Pole 50.d. and 52.d. which you may likewise use without any notable difference, where the Pole is Elevated 49.d. 51.d. and 53.d.



*The first Table calculated for  
50. degrees.*

Hour	Hour	$\odot$		$\gamma \approx$		$\gamma \rho$		10 deg. 8.		10 deg. 11.	
		D.	M.	D.	M.	D.	M.	D.	M.	D.	M.
	12	63	30	40	0	16	30				
11	1	61	2	38	23	15	19				
10	2	54	42	33	50	11	51				
9	3	46	15	27	2	6	24				
8	4	36	53	18	45			30	23		
7	5	27	15	9	35			20	55		
6	6	17	47	0	0			11	19		
5	7	8	48					2	3	7	14
4	8	0	36							0	0



# The Art of Dialling.

## The second Table calculated for

50. degrees of latitude.

Hour	Hour	☉		☽		♊		10 deg. ☉		10 deg. ♊	
		D.	M.	D.	M.	D.	M.	D.	M.	D.	M.
	12	61	30	38	0	14	30				
11	1	59	13	36	28	13	21				
10	2	53	15	32	7	10	0				
9	3	45	12	25	33	4	45				
8	4	36	12	17	32			29	36		
7	5	26	53	8	46			19	22		
6	6	17	42	0	0			11	4		
5	7	8	58					2	47	46	
4	8	1	1					0	0	0	0

If therefore you will make your Quadrant Horologically for the Elevation of the Pole 50. °. extend a thread, or lay a Ruler, from the centre E. by the 63.°. 30. m. of the limbe of the Quadrant, beginning at F. and where the thread so placed shall touch the Tropike of ☉, there make a point or marke. Againe, let the thread be placed vpon the 40.°. of the limbe, and where it shall touch the Equator, there also make a marke. Thirdly, let the thread be drawne by the 16.°. 30. m. of the quadrant: and where it shall touch the Tropike of ♊, there make likewise a marke. This done, search out the centre (by the 5 Proposition 4 Euclid) and ioyn these three markes into one Arke, which shall bee the line for the 12 houre. Afterward place the thread vpon the 61.°. 2. m. of the limbe, and where it shall cut the Tropike of ☉, note it. Draw likewise the thread vpon the 38.°. 23. m. of the limbe,

limbe, marke where it cutteth the Equator. Then by the 15.<sup>d</sup>. 19.<sup>m</sup>. of the limbe extend the thread, making a marke in the section thereof and the Tropike of  $\Psi$ . Draw into one Arke these three markes (as you did before) finding out the common centre: so shall you haue the line of the 11 houre before none, and 1 afternone. In like manner are the rest of the houre lines drawne by three points, accounted and found out by the altitude of the Sunne. But because before 9 and after three, in this Elevation of the Pole, it will not serue for this delineation, there must another bee made by the Table of the 12 Signes or Quadrangles. Therefore draw that from the 10.<sup>d</sup>. of  $\delta$ , so shall you haue a line or place wherein the third points may bee marked. Then to prepare the points of the Arke for the houre of 8 and 4 of 7 and 5 and both the 6 besides the two markes made in the Tropike of  $\delta$  and the Equator, let the third be noted in the Arke drawne from the 10 degree of  $\delta$ . To draw the line of the 5 and 7 houres, vse besides the Tropike of Cancer, and this drawne from the 10 degree of  $\delta$ , the third which shall come from the beginning of  $\Pi$ . The line of 4 in the morning, and 8 in the evening is very short; included in the angle next unto I. Thus you haue finished 9 Arkes or lines for the houres, of which each one of them doth shew 2 houres: except one which is onely for the 12 houre.

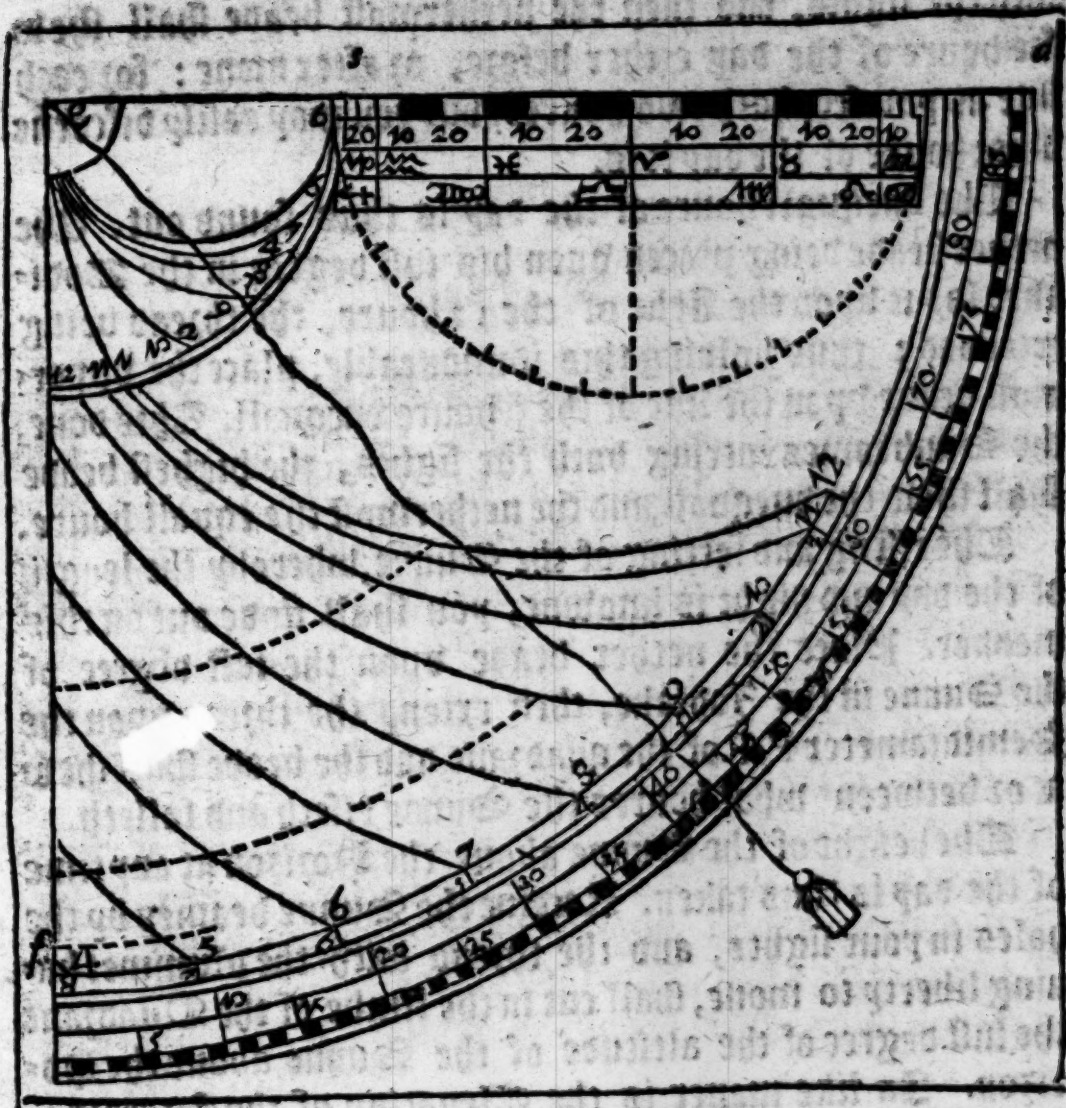
And to the intent that there should bee no space left voyd and vnprofitable betweene the Tropike of  $\Psi$  and the centre E. you may draw in that place the vnequall houres, which you shall very easily doe on this manner. Describe vpon the centre E. an Arke very little distant from the Tropike of  $\Psi$ , to bee divided into 6 equall parts, and take the middle point betweene the beginning of that Arke at S. and betweene E. Then vpon this point, as it were a centre, make a halfe circle from S. to E. which shall bee the line of the 6 vnequall houre, that is of midday. Afterward one foot of the Compasses being placed in the same Semidiameter E.D. and remoued each way as occasion shall require:



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and the other extended in the meane time so farre, that it may touch the second point of the Arke diuided into 6 parts, and the centre E. draw an Arke or line from the centre to that point, which shall shew the 5 and 7 houres. In like maner are the other 4 drawne, one foot of the Compasses being removed, as necessity shall require, in the Semidiameter E.D. (which may bee prolonged if it shall bee too short) and the Compasses so opened, that the other foot may touch the point of the diuided Arke and the centre E. and layne them all into one Arke line: then fixe a thread in the centre E. well waxed, hauing two small beades vpon it to moue with a plummet of iron or lead. Last of all prepare two sights of brass or other metall with topes, which you must place in one right line vpon the side or edge A.B. so that you may direct them, and againe turne them downe vpon that side A.B. at your pleasure: that (if you make this Diall vpon the Table or instrument prescribed in the beginning of this booke) they be no hindrance to you in tryng or examining of your plates. Thus is your Diall prepared: but for further instruction behold the Figure.

The



The vse of this Diall or Quadrant  
Horologicall.

**I** know the houre of the day when the Sunne  
shineth, worke thus. First, seeke out in some  
Calender in what signe and degree the Sunne  
is at that day: then extend the thread with the  
beades vpon the Semidiameter E.D. and  
place the nethermost beade vpon that degree, in the Table  
of the 12 Signes, which the Sunne then occupieth. After-  
ward lifting vp your Quadrant, the thread with the plumb  
met hanging at liberty, let the Sunne beames passe thorow  
both



# The Art of Dialling.

both the sights, and then the nethermost beade shall shew the houre of the day either before, or after noone: for each line as you see, hath two houres, but you may easily discern what houre of the day it is.

The vnequall houre of the day is thus found out. The nether beade being placed vpon his iust degree in the Zodiacke, lay it vpon the Arke of the 12 houre, the thread being extended: thus holding this immouable, place the vppermost beade vpon the line of the 6 houre vnequall. This done, the Sunbeames entering both the sights, the highest beade shall shew the vnequall, and the nethermost the equall houre.

The rising and setting of the Sunne, whereby the length of the day and night is knowne, you shall finde out on this manner. Place the nether beade vpon the iust degree of the Sunne in the Zodiacke, then extend the thread vpon the Semidiameter E.F. of the quadrant, and the beade shall shew at or betwene what houres the Sunne riseth and falleth.

The height of the Sunne aboue the Horizon at any time of the day is thus taken. Receiue the Sunne beames by the holes in your sights, and the thread with the plummet having liberty to moue, shall cut in the limbe of the Quadrant the iust degree of the altitude of the Sunne aboue the Horizon. In like maner is the Elevation of the Starres aboue the Horizon searched out.

You shall finde out the Elevation of the Pole by the helpe of your Quadrant, thus. Take the height of the Sunne at 12 of the clocke, when the dayes and nights bee of equall length, which being subtracted from 90.d. the Elevation remaineth. But if you assay that vpon any other day than the Equinoctiall, you must consider whether the Sunne occupieth the North, or the South signes, and then vse the table of the Declination of the Sunne on this wise. When the Sunne is in the North Signes, subtract his Declination from the Meridian height thereof. But if it be in the South signes, adde the Declination to his Meridian altitude. The remainder or totall summe being taken from 90.d. the Ele-

How to make an instrument, whereby you may know  
the iust houre of the night by the  
Starres.

## CHAP. 27.



First prepare a plat or Table of  
Brasse or firme and solid wood,  
which will not change or bend,  
somewhat thinne, let the forme of  
it bee round, three inches broad, or  
more or lesse as you will. Draw  
a circle nigh unto the edge, and  
divide it into 12 equall parts:  
wherein shall bee placed the 12  
Signes of the Zodiacke, then divide each of these parts into  
30 equall parts, which shall shew the number of the dayes  
that the Sunne moueth in euery Signe. Make a second cir-  
cle, wherein you may number the dayes, and a third circle,  
wherein write the Characters of the 12 Signes, as you see  
in the Figure following.

Draw likewise another circle, wherein you may write  
the dayes of euery moneth in the yeare, which you may doe  
by any Calender, but for more easinesse behold the Table fol-  
lowing, whereby you may likewise doe it.

**H**

**Enter**



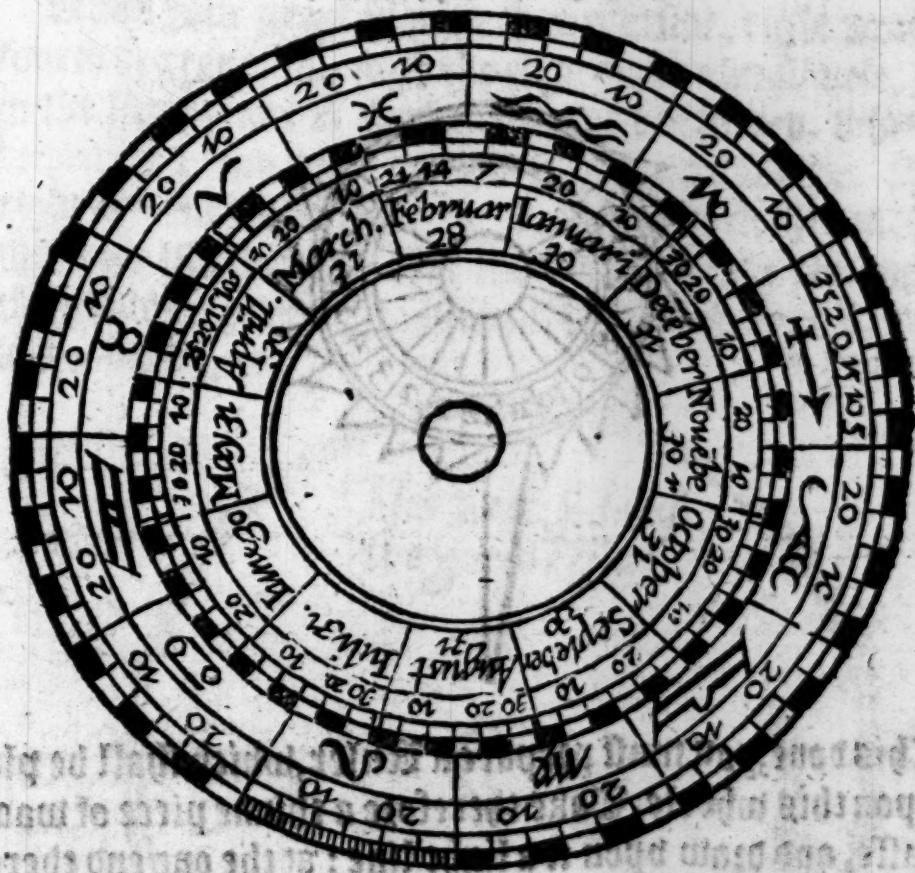
# The Art of Dialling.

Month.	Dayes.	Deg.	M.	Characters of the 12 Signes.	Signes.
January	1	20	13	♑	Capricorne
	15	5	33	♒	Aquarius
	31	21	44	♓	Pisces
February	14	5	52	♈	Aries
	28	19	48	♉	Taurus
March	15	4	36	♊	Gemini
	31	2	18	♋	Cancer
April	15	40	51	♌	Leo
	30	19	13	♍	Virgo
May	15	4	38	♎	Libra
	3	18	50	♏	Scorpius
June	15	3	3	♐	Sagittarius
	30	17	22	♑	Capricorne
July	15	1	40	♒	Aquarius
	31	16	58	♓	Pisces
August	15	1	24	♈	Aries
	31	16	58	♉	Taurus
Septem.	15	1	40	♊	Gemini
	30	16	03	♋	Cancer
October	15	1	30	♌	Leo
	31	17	43	♍	Virgo
November	15	8	30	♎	Libra
	30	18	13	♏	Scorpius
December	15	3	38	♐	Sagittarius
				♑	Capricorne

Enter this Table, and you shall finde that the first day of January must bee placed against the 20.d. 13.m. of Capricorne, and the 15 day against the 5.d. 33.m. of Aquarius, &c.

Wherefore lay your Ruler vpon the centre A. of your plate and vpon the 20.d. 13.m. of ♑, and where it shall touch the circle which you made for the dayes of every moneth, there make a marke which shall shew the first day of January. Then lay it vpon the 5.d. 33.m. of ♒ and the centre A. and where it shall touch the circle, make a marke for the 15 day of January. Then lay your Ruler vpon A. and the 21.d. 44.m. of ♓, and make likewise a marke for the 31 day of January. Againe place the Ruler vpon the centre A. and the 5.d.

5. d. 12. m. of  $\Sigma$ , for the 14 day of February: worke thus with all the rest, untill you haue set downe the beginning and middest of euery moneth, as the Table both direct you, then hauing found out the beginning and middest of euery moneth you may at ease diuise euery space into so many parts, as there be dayes in the moneth, which it serueth for, according as you see in this Figure following. It shall be also necessary to make one circle to write the number of the dayes of the moneth, and another for the names of the moneths: you must make also a hole in the centre of this plat, of such bignesse, as you may see a Starre thorow it: as in the Figure you may perceiue.



Hauing prepared this plat with the circles vpon it, for the 12 Signes and moneths, you must prepare another whole full of reech, which you shall make on this maner.

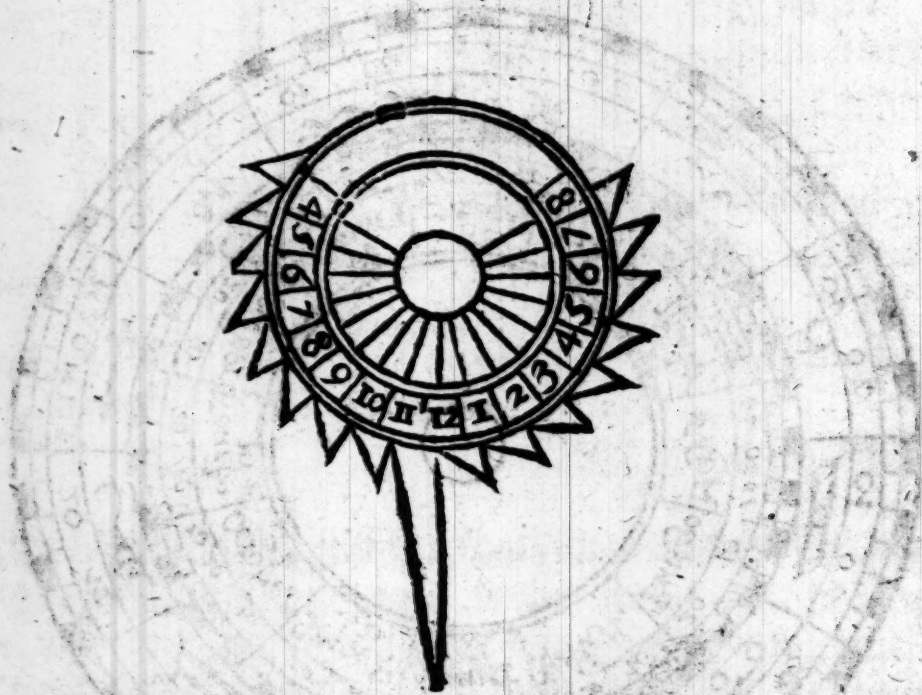
Take a thinne Table or plat of the same matter pour



# The Art of Dialling.

other was, draw a circle vpon it so great as the inwards circle of the first plat, and diuide it into 24 equall parts. Then draw lines from the centre to euery one of those parts, buttill you haue so many as there be houres in the longest night in your Countrey. Then cut teeth by these lines for the houres, and write the number of them vpon the teeth as you see in this Figure. Let the tooth for the 12 houre be so long from the centre to the end, as is betweene the centre A. of the other plat, and the circle of the 12 Signes: you must likewise make a hole in the centre of this wheele, of the same bignesse of that in the other plat.

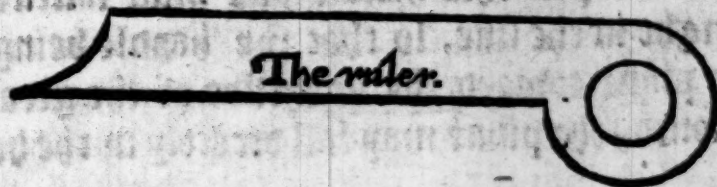
## The Tothed Wheele.



This done, you must prepare a Ruler, which shall be placed vpon this wheele. Take therefore a thinn piece of wood or brasse, and draw vpon it a light line: at the one end thereof in the midst of the line make a hole of the same bignesse which that is in the great plat and Tothed wheele. Then draw a circle halfe an inch wide or more if you wilt, afterward cut the Ruler round at the end, cutting off likewise the one halfe of the breadth of the Ruler by the line.

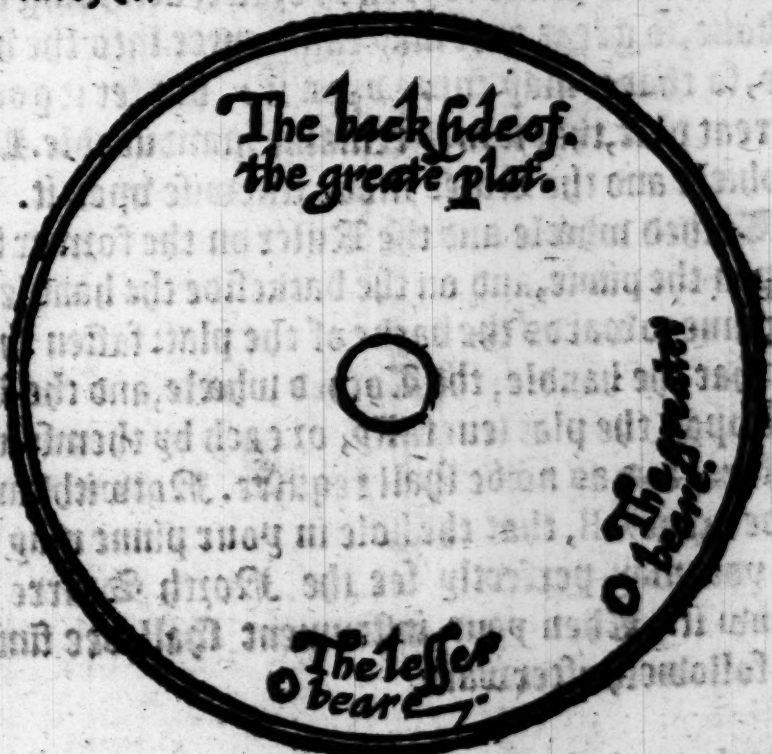
Let

Let the length of the Ruler from the centre to the end be of such quantitie, as is from the centre of the great plat to the outward edge, and an inch or more if you will.



The foreside of your Instrument being finished: the backside must haue two small holes, and a handle, which may turne and moue about. Prepare them thus.

Upon your great plat on the backside, right against the fourth degree of  $m$ , nigh the edge make a small hole, wherein the little pinne of the handle may bee placed, when neede requireth: and write by this the greater Beare. Againe, right against the  $28.d.1.m.$  of  $\alpha$  on the backside make another hole likewise, so that the handle being remoued to it, the pinne may enter, as in the other. And by this, write the lesser Beare, &c.

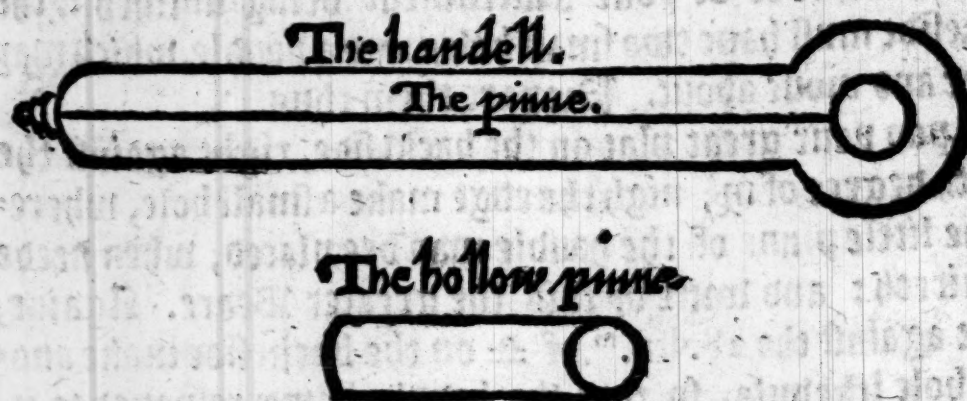




# The Art of Dialling.

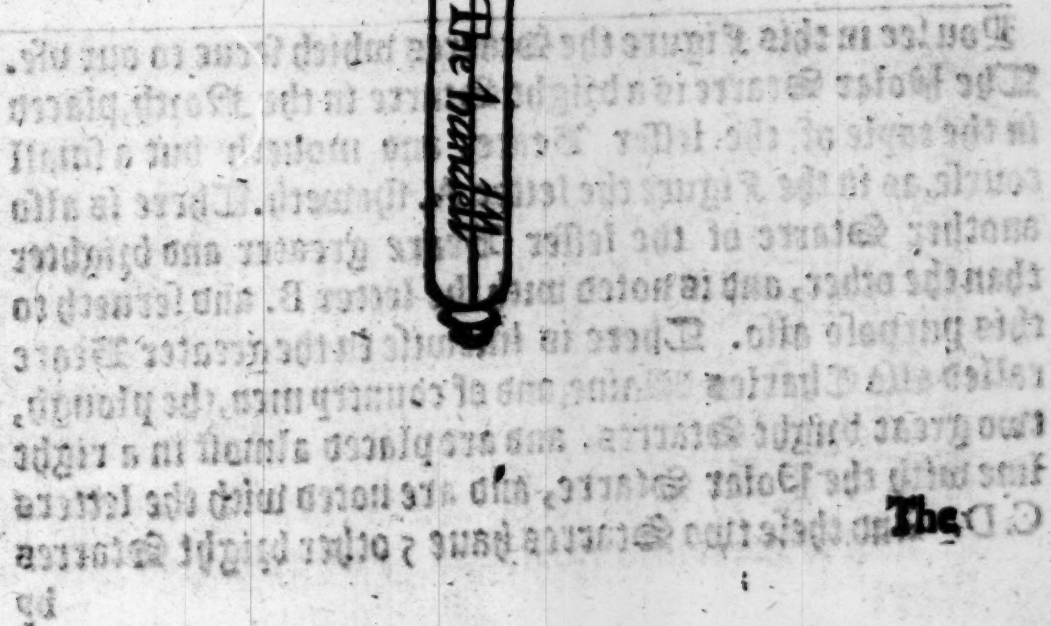
Prepare for your handle a thinne plat of yron, brasse, or wood, about 6 inches in length, or more if you will. Draw in the middest of it a line; at the one end thereof make a hole in the middest of the line, of such bignesse as the hole in the greater plat is. Upon this handle you must fasten a little short pinne right in the line, so that the handle being fastened with the pinne toward the backside of the great plat, and being moued, the pinne may fall directly in the hole.

Behold the Figure following.



Prepare a hollow pinne of yron or brasse, according to this Figure aboue, so great as it may easily enter into the hole of the handle, so that it may turne vpon it: but let it goe close into the great plat, that it may remaine immouable. Let the Tothed wheele and the Ruler moue likewise vpon it. Then place the Tothed wheele and the Ruler on the former side of the plat vpon the pinne, and on the backside the handle with the little pinne towards the backe of the plat: fasten them so together, that the handle, the Tothed wheele, and the Ruler may turne vpon the plat leuerally, or each by themselves at your pleasure, and as neede shall require. Notwithstanding you must bee carefull, that the hole in your pinne may bee so great, as you may perfectly see the North Starre in the night thorow it. Then your instrument shall bee finished, whose vse followeth after ward.

For better instruction behold the Figure.

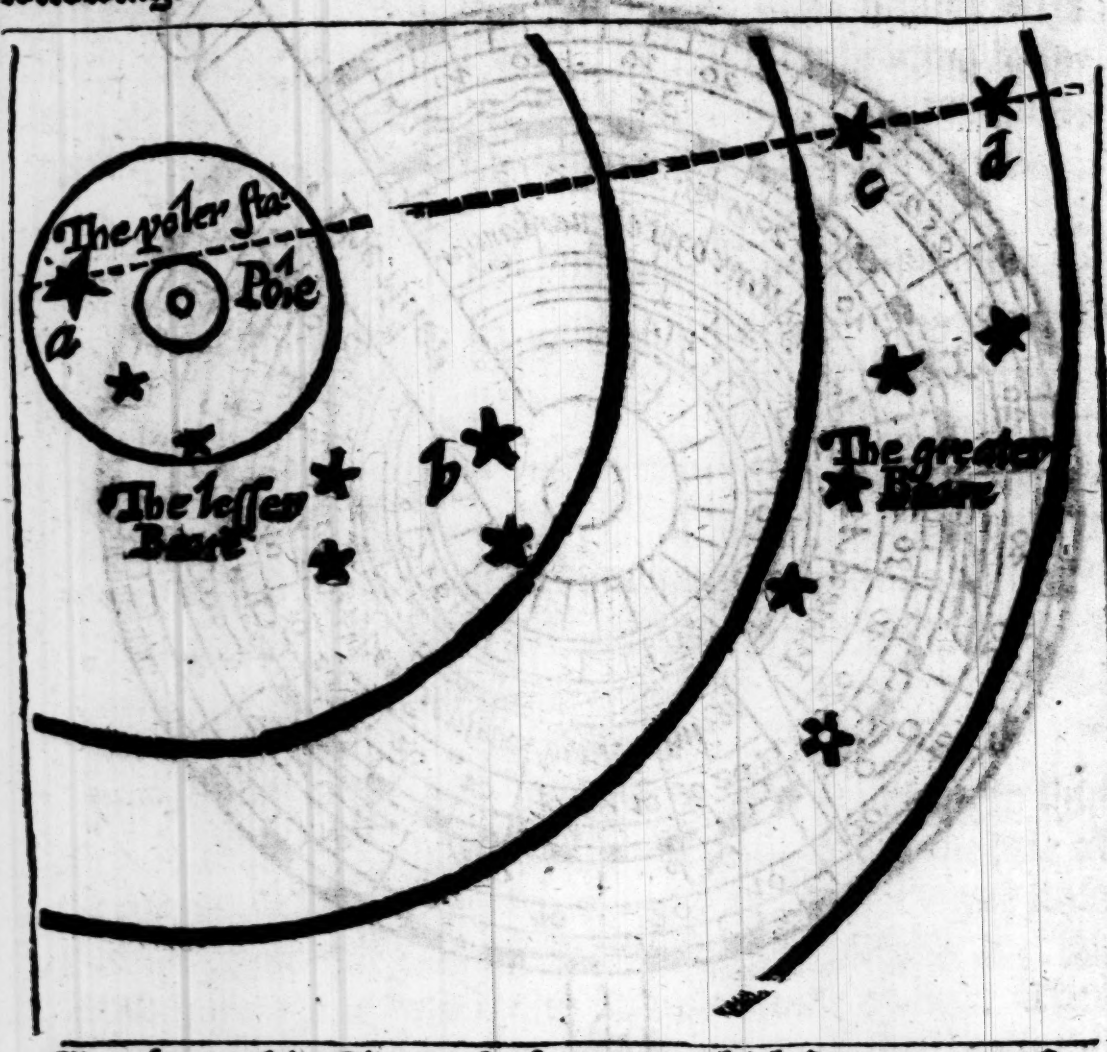




# The Art of Dialling.

The vse of this Instrument.

**F**irst it shall bee expedient to finde out the Starres ser-  
uing to this purpose, which you may doe by the Figure  
following.



You see in this Figure the Starres which serue to our vse. The Polar Starre is a bright Starre in the North, placed in the tayle of the lesser Beare, and moueth but a small course, as in the Figure the letter A. sheweth. There is also another Starre of the lesser Beare greater and brighter than the other, and is noted with the letter B. and serueth to this purpose also. There is likewise in the greater Beare called also Charles Waine, and of country men, the plough, two great bright Starres, and are placed almost in a right line with the Polar Starre, and are noted with the letters C. D. And these two Starres haue 5 other bright Starres by

by them, but not so great as the other bee. These Starres which you see in the Figure, as all other, mooue equally about the Pole, and finish their course in 24. houres.

Therefore when you would know the houre of the night by this instrument, doe thus: Place the right line of the long tooth of the 12 houre directly ouer the day of the moneth, and turne the handle on the backside to the hole of the greater Beare, and your Instrument shall be prepared.

Then lift vp your Instrument by the handle perpendicularly, so that it declineth on neither sides: and beholding the Polare Starre thorow the hole in the centre, moue the Ruler about, vntill the right line thereof be directly against, or seemeth to touch the two Starres of the greater Beare, and vnder the line you shall haue the iust houre of the night: which you may finde out by the number of the teeth with your Figure in the night. But if you cannot see the two Starres of the greater Beare, because of Cloudes: and yet you may see the Polare Starre, and the Starre of the lesser Beare, noted with the letter B. remoue the handle on the backside to the hole of the lesser Beare. Then lift vp your Instrument as before, and behold the Polare Starre at the hole, and turne the Ruler to the fore said Starre of the lesser Beare, and you shall finde the true houre of the night, as before is taught.

The making of a Diall, to know the houre by the Moone.

## CHAP. 30.

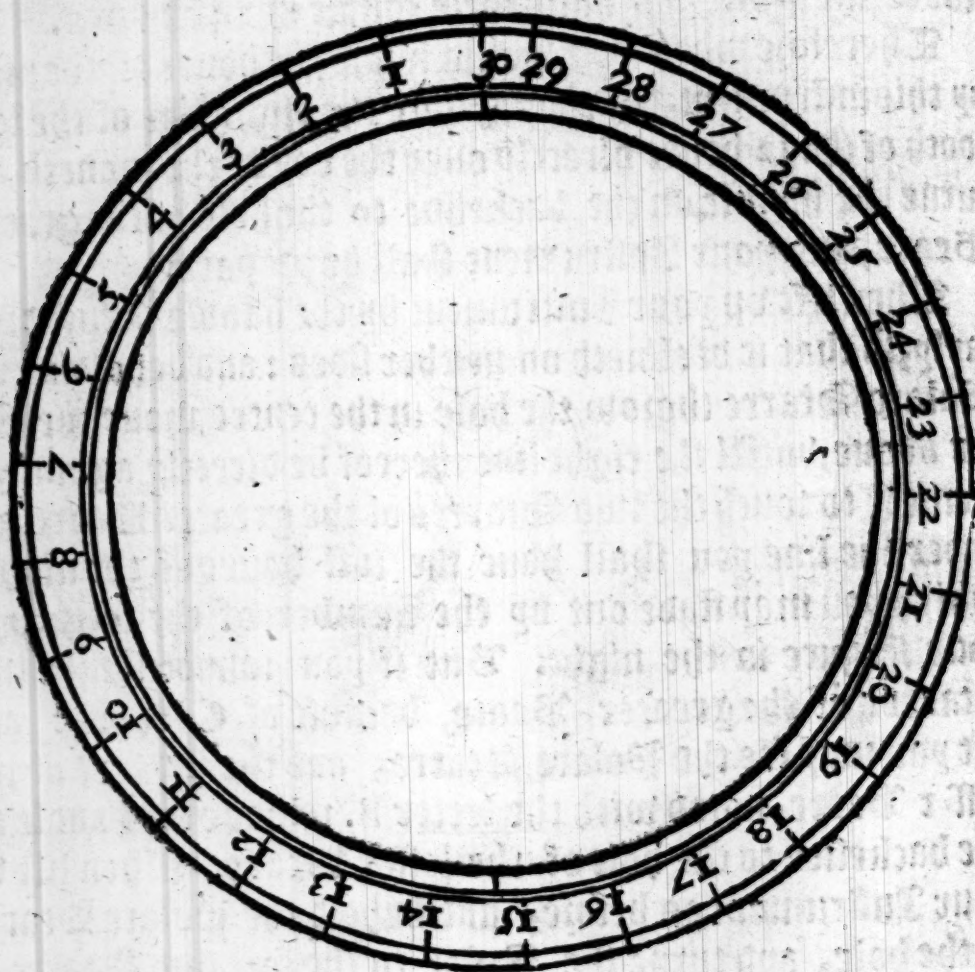


Repare a square piece of wood or metal 3 or 4 inches ouer, draw thereon a circle so great as you can, draw also another within that. Now because the Moone finisheth her course in 29 daies, 12 houres, and 44 minutes, part the inward into 30 parts in this maner, let 29 be equally diuided, and the 30 which is the last must not be so great by a third part: wherefore diuide one of these 29



# The Art of Dialling.

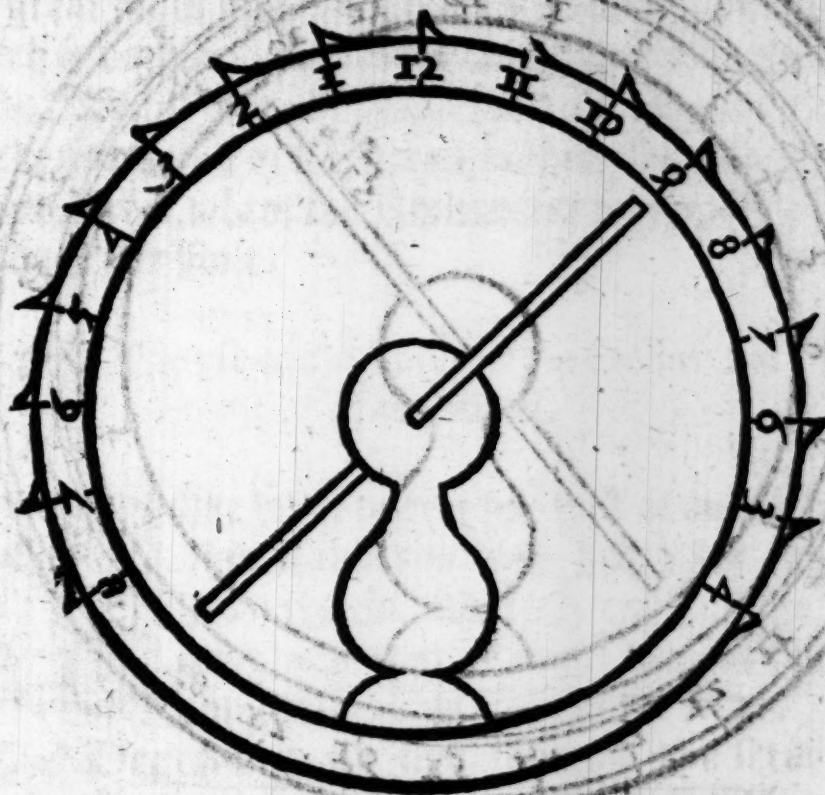
equall parts into three parts, and take two of them for the 30. and last part.



Cut out that which is within the inward limbe, and prepare another of the same, or like wood or metall somewhat thicker, and worke it so that it may goe into the former, so much of the thickenesse as it may be equall on the backside, and that which remaineth of the thickenesse, let it hang over the foreside of the first plat, to keepe it from falling thorow: draw a circle vpon it, and diuide it into 24 equall parts. draw from these parts houre lines so many as shall suffice for the longest night: cut that which overhangeth with teeth at every houre, but especially at the 12 houre make a long tooth, fixe a wyer in the centre for the stile equally distant from the circle on each side. Let the stile hang so much

# The Art of Dialling. 58

much beneath the plat, as it is above, because you shall have as much use on the backside as before.



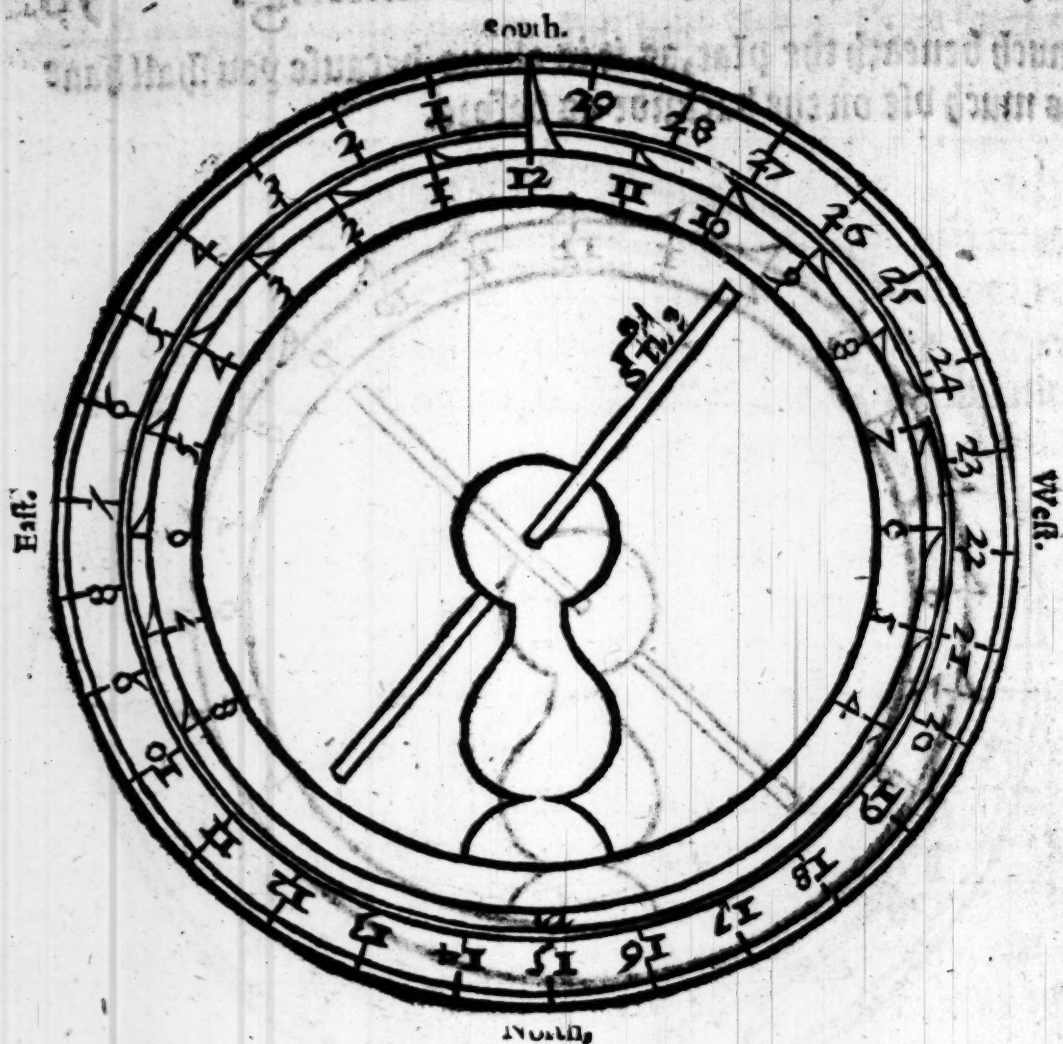
Cut out all that which is within the inward circle, except a little portion to support the stile, so that this shall be but a hoope. Draw the houre lines one the backside of this plat, as on the foreside, so that the one may be right against another: then draw lines on the inside, from every one of these lines on the foreside, to the lines of the backside. This plat or wheele must bee moueable, and turne within the former.

Q. 2

South



# The Art of Dialling.



## The vse of this Diall.

**P**Lace this Dial that each side may behold one quarter of the world precisely: the South side the South, the North side the North, &c. Moreover, it must recline according to the elevation of the Equinoctiall, so that the Moone being in the Equinoctiall circle, shall giue light both aboue and beneath this Diall. You may place it perfectly with your Instrument.

Your Diall being thus placed, when you would know the houre of the night, first learne the age of the Moone by an almanack, and especially the houre of the change, then turne the great ouer-hanging tooth, to the day of the Moone on the first limb, and the houre of the change, accounting from 12. of the clocke.

The

# The Art of Dialling.

59

The shadow of the stile shall be in the houre of the night  
either beneath your Diall or else aboue.

This Diall will serue also for the Sunne, if you turne the great tooth of the moueable wheele to the little strick A. which is right opposite to the beginning of the first, and end of the last day of the Moone, neere  $\text{p } 15.$  day, and then it is fit for the Sunne. For it differeth nothing from the North reclining direct, where the Reclination is equall to the Elevation of the Pole.

# The vse of the Table of the declination of the Sunne.

**T**ake what degree you will of any signe, and by this Table you may know his declination from the Equinoctiall circle. The Signes are written partly on the head of the Table, and partly on the foote of the same.

The Degrees in the first colunne doe serue for the Signes that bee on the head of the Table, and the Degrees in the last colunne doe serue for the Signes in the foote of the Table. And the common Area or angle against the Signe and the degree which you seeke for, both containe the Degrees and Minutes of the Declination due to the same.

**Example.**

I would know how much the tenth degree of Leo doth decline from the Equinoctial: I must look in the columnne over Leo, right against the number of 10. in the last column where I finde 17.<sup>d</sup>.46. the declination thereof, &c.

[illegible]



# The Art of Dialling.

The Table of the declination of the Sunne,  
from the Equinoctial circle.

		<i>Aries.</i> <i>Libra.</i>		<i>Taurus.</i> <i>Scorpius.</i>		<i>Gemini.</i> <i>Sagittarius.</i>			
<i>Deg.</i>	<i>Deg.</i>	<i>M.</i>	<i>Deg.</i>	<i>M.</i>	<i>Deg.</i>	<i>M.</i>	<i>Deg.</i>	<i>M.</i>	<i>Deg.</i>
1	0	24	11	30	20	12	29		
2	0	48	12	11	20	35	28		
3	1	12	12	31	20	47	27		
4	1	36	12	52	20	58	26		
5	1	59	13	12	21	9	25		
6	2	23	13	32	21	20	24		
7	2	47	13	52	21	30	23		
8	3	11	14	12	21	40	22		
9	3	34	14	31	21	49	21		
10	3	58	14	50	21	58	20		
11	4	21	15	9	22	7	19		
12	4	45	15	27	22	15	18		
13	5	8	15	55	22	23	17		
14	5	32	16	3	22	30	16		
15	5	55	16	21	22	37	15		
16	6	18	16	39	22	44	14		
17	6	14	16	56	22	50	13		
18	7	4	17	12	22	55	12		
19	7	27	17	29	23	1	11		
20	7	50	7	46	23	5	0		
21	8	12	18	2	3	10	9		
22	8	36	18	17	23	13	8		
23	8	57	18	33	23	17	7		
24	9	10	18	48	23	20	6		
25	9	41	19	2	23	22	5		
26	10	3	19	17	23	24	4		
27	10	25	19	31	23	26	3		
28	10	47	19	40	23	28	2		
29	11	8	19	50	23	29	1		
30	11	29	20	12	23	30	0		
<i>Deg.</i>	<i>Deg.</i>	<i>M.</i>	<i>Deg.</i>	<i>M.</i>	<i>Deg.</i>	<i>M.</i>	<i>Deg.</i>	<i>M.</i>	<i>Deg.</i>
		<i>Virgo.</i> <i>Pisces.</i>		<i>Leo.</i> <i>Aquarius.</i>		<i>Cancer.</i> <i>Capricorne.</i>			

*The Table of Sines.*

The whole Sine containeth 100000. parts.

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## The vse of the Table of Sines.

**W**hereas the making of some Dials, and this Table of Sines may seeme obscure and hard to them who are not acquainted with Sine-calculation, it shall bee expedient to declare the vse hereof, so much as pertaineth to the vnderstanding of this booke, omitting all other vses as impertinent to our present purpose. Wherefore know that the Grades or Degrees are found in the vpper head of this Table, and the Minutes pertaining to the Degrees on the left side, & in the Area or common meeting of them both, a number which is called the Sine, answerable to each Degree and Minute, offereth it selfe. Againe, the Sine being found out, you may easily know the Arke, that is, the Degree and Minutes thereof, these being on the left hand, the other on the head or vpper part. Understand by the Complement that which remaineth of any number being taken or subtracted from 90. Degrees. If at any time you enter the Table with iust Degrees without any Minutes, resolve one Degree into 60. Minutes, and then seeke out his Sine. And whereas you shall finde some numbers imperfect, you must remember to supply their want with those which be perfect immediately going before.

## Example.

The Elevation of the Pole at Cambr. is 52. Degrees, whose Sine I desire to know, therefore resolving one of the Degrees into Minutes, I enter the Table with 51. Degrees,



# The Art of Dialling.

degrees, 60. Minutes, and the common Area I find the Sine to be 78801. If then you desire to know the complement of this Elevation, subtract 52. out of 90. and the remainder shall be 38. the complement thereof, and entering the Table with 37.<sup>d</sup>. 60.<sup>m</sup>. you shall finde in the Area 66. which number because it is imperfect, you must supply the want thereof by adding the 3. former figures in that which is next before perfect, to wit, 615. and then the whole number shall be 61566. the Sine of 38.<sup>d</sup>. Which is the Complement of 52.<sup>d</sup>. the Elevation of the Pole.

These things well considered, there is nothing in the booke so obscure, but it shall seeme plaine and easie.

*Μολὴν ἀνὰ θυμὸν δουλεύει*

**FIN IS.**

1	1774	2001	2004	8744
2	1805	2001	2004	8744
3	2001	2001	2004	8744
4	2001	2001	2004	8744
5	2001	2001	2004	8744
6	2001	2001	2004	8744
7	2001	2001	2004	8744
8	2001	2001	2004	8744
9	2001	2001	2004	8744
10	2001	2001	2004	8744
11	2001	2001	2004	8744
12	2001	2001	2004	8744
13	2001	2001	2004	8744
14	2001	2001	2004	8744
15	2001	2001	2004	8744
16	2001	2001	2004	8744
17	2001	2001	2004	8744
18	2001	2001	2004	8744
19	2001	2001	2004	8744
20	2001	2001	2004	8744
21	2001	2001	2004	8744
22	2001	2001	2004	8744
23	2001	2001	2004	8744
24	2001	2001	2004	8744
25	2001	2001	2004	8744
26	2001	2001	2004	8744
27	2001	2001	2004	8744
28	2001	2001	2004	8744
29	2001	2001	2004	8744
30	2001	2001	2004	8744



D	0	1	2	3	4	5
M	Parts	Parts	Parts	Parts	Parts	Parts
1	29	1774	3519	5262	7004	8744
2	58	1803	48	91	33	73
3	87	32	77	5320	62	8803
4	116	61	3606	49	19	31
5	45	90	35	78	7120	60
6	74	1919	64	5407	49	89
7	203	48	93	36	78	8918
8	32	77	3722	65	7207	47
9	61	2007	51	95	36	76
10	90	36	80	5524	65	9005
11	319	65	3809	53	94	34
12	49	94	38	82	7323	63
13	78	2123	67	5611	52	92
14	407	52	96	40	81	9121
15	36	81	3925	69	7410	50
16	65	2210	55	98	39	79
17	94	39	84	5727	68	9208
18	523	68	4013	56	97	37
19	52	97	42	85	7526	66
20	81	2326	71	5814	55	94
21	610	55	4100	43	84	9323
22	39	85	29	72	7613	52
23	69	2414	58	5901	42	81
24	98	43	87	30	71	9410
25	727	72	4216	59	7700	39
26	56	2501	45	88	29	68
27	85	30	74	6017	58	97
28	814	59	4303	46	87	9526
29	43	88	32	75	7816	55
30	73	2617	61	6104	45	84

D	0	1	2	3	4	5
M	Parts	Parts	Parts	Parts	Parts	Parts
31	901	2646	4391	6133	7874	9613
32	30	75	4420	62	7903	42
33	59	2704	49	91	32	71
34	89	34	78	6220	61	9700
35	1018	63	4507	50	90	29
36	47	92	36	79	8019	58
37	76	2821	65	6308	48	87
38	1105	50	94	37	77	9816
39	34	79	4622	66	8106	45
40	63	2908	52	95	35	74
41	92	37	81	6424	64	9903
42	1221	66	4710	53	93	31
43	50	95	39	82	8222	60
44	79	3034	68	6511	51	89
45	1208	53	97	40	80	10018
46	38	82	4826	69	8309	47
47	67	3112	55	98	38	76
48	96	41	84	6627	67	10105
49	1425	70	4914	56	96	34
50	54	99	43	85	8425	65
51	83	3228	72	6714	54	92
52	1512	57	5001	43	83	10221
53	41	86	30	72	8512	50
54	70	3315	59	6801	31	79
55	99	44	88	30	70	10308
56	1628	73	5117	59	99	37
57	57	3402	46	88	8628	69
58	87	31	75	6917	57	94
59	1716	60	5204	46	86	10423
60	45	89	33	75	8715	52



D	6	7	8	9	10	11
M	Parts	Parts	Parts	Parts	Parts	Parts
1	10481	12215	13946	15672	17393	19109
2	10510	44	74	15700	17422	38
3	39	73	14003	29	50	66
4	68	2302	32	57	97	95
5	97	31	61	87	17508	19223
6	10626	60	90	15801	36	52
7	55	89	14118	44	65	80
8	84	12417	47	73	93	13909
9	10713	46	76	15901	17622	37
10	42	75	14205	30	51	66
11	71	12504	34	59	79	94
12	99	33	62	88	17708	19423
13	10828	62	91	16016	37	51
14	57	91	14320	45	65	80
15	8	12619	94	74	94	19500
16	10915	48	78	16102	17822	37
17	44	77	14406	31	51	66
18	73	12706	35	60	80	94
19	11002	35	64	89	17908	19623
20	31	64	93	16217	37	51
21	60	93	14521	46	66	80
22	89	12821	50	75	94	19708
23	11119	50	79	6302	18023	37
24	46	79	14608	32	51	65
25	75	12908	37	61	80	95
26	11204	37	65	89	18109	19822
27	33	66	94	16418	37	51
28	62	94	14723	47	66	79
29	191	13023	52	76	94	19908
30	11320	52	80	16504	18223	36

D	6	7	8	9	10	11
M	Parts	Parts	Parts	Parts	Parts	Parts
31	11349	13081	14809	16533	18252	19965
32	78	13110	38	62	80	93
33	11407	39	67	90	18309	20022
34	35	67	96	16619	37	50
35	64	96	14924	48	66	79
36	93	13215	53	76	95	20107
37	11522	54	82	16705	18423	36
38	51	83	15011	34	52	64
39	80	13312	39	62	80	93
40	11609	40	68	91	18509	20231
41	38	69	97	16820	38	50
42	67	98	15126	48	66	78
43	95	13427	54	77	95	20307
44	11724	56	83	16906	18623	35
45	53	85	15212	34	52	64
46	82	13513	41	63	80	92
47	11811	42	69	92	18709	20421
48	40	71	98	17020	38	49
49	69	13600	15327	49	66	78
50	98	29	56	78	95	20506
51	11927	58	84	17106	18823	35
52	55	86	15413	35	52	63
53	84	13715	42	64	80	93
54	12013	44	71	92	18909	20620
55	42	73	99	17221	38	48
56	71	13802	15528	50	65	77
57	12100	30	57	78	99	20705
58	29	59	85	17307	19023	34
59	58	88	15614	36	52	62
60	86	13917	43	64	80	91



D	I2	I3	I4	I5	I6	I7
M	Parts	Parts	Parts	Parts	Parts	Parts
1	20819	22523	24220	25910	27591	29264
2	48	51	48	38	27619	92
3	76	80	76	66	47	29320
4	20904	22608	24305	94	75	48
5	33	36	33	26022	27703	76
6	61	65	61	50	31	29404
7	90	93	89	78	59	31
8	21018	22721	24417	26106	87	59
9	47	50	46	34	27815	87
10	75	78	74	62	43	29515
11	21104	22806	24502	90	71	43
12	32	35	30	26218	99	70
13	60	63	58	46	27927	98
14	89	91	87	75	54	29626
15	21217	22920	24615	26303	82	54
16	46	48	43	31	28010	81
17	74	76	71	59	38	29709
18	21303	23004	99	87	66	37
19	31	33	24728	26415	94	65
20	59	61	56	43	28122	93
21	88	89	84	71	50	29820
22	21416	23118	24812	99	78	48
23	45	46	40	26527	28206	76
24	73	74	69	55	34	29904
25	21501	23203	97	83	62	31
26	30	31	24925	26611	89	59
27	58	59	53	39	28317	87
28	87	87	81	67	47	30015
29	21615	23316	25009	95	73	42
30	43	44	38	26723	28401	70

D	12	13	14	15	16	17
M	Parts	Parts	Parts	Parts	Parts	Parts
31	21672	23372	25066	26751	28429	30098
32	21700	23401	94	79	57	30126
33	29	29	25122	26807	85	53
34	57	57	50	35	28513	81
35	85	85	78	63	40	30209
36	21814	13514	25206	91	68	36
37	42	42	35	26920	96	64
38	71	70	63	48	28624	92
39	99	99	94	76	52	30320
40	21927	23627	25319	27004	80	47
41	56	55	47	32	28708	75
42	84	83	75	60	36	30402
43	22013	23712	25403	88	63	31
44	41	40	32	27116	91	58
45	69	68	60	44	28819	86
46	98	96	88	72	47	30514
47	22126	23825	25516	27200	75	41
48	54	53	44	28	28903	69
49	83	81	72	56	31	97
50	22211	23909	25600	84	58	30624
51	39	38	28	17311	86	52
52	68	66	57	39	29014	80
53	96	94	85	67	42	30707
54	22325	24022	25713	95	70	35
55	53	51	41	27423	98	63
56	81	79	69	51	29125	91
57	22410	24107	97	79	53	30818
58	38	35	25825	27507	81	46
59	66	63	53	35	29209	74
60	95	92	81	63	37	30901



D	18	19	20	21	22	23
M	Parts	Parts	Parts	Parts	Parts	Parts
1	30929	32584	34229	35863	37487	39909
2	57	32611	56	91	37514	39126
3	84	39	84	35918	41	53
4	31012	66	34311	45	68	80
5	39	94	38	72	95	39206
6	67	32721	65	99	37622	33
7	95	49	93	36029	49	60
8	31122	76	34420	53	76	87
9	50	32804	47	81	37703	39313
10	78	31	75	36108	30	40
11	31205	59	34502	35	57	67
12	33	86	29	62	84	94
13	61	32914	57	89	37811	39420
14	88	41	84	36216	37	47
15	31316	69	34611	43	64	74
16	44	96	39	70	91	39501
17	71	33023	66	98	37918	27
18	99	51	93	36325	45	54
19	31426	78	34720	52	72	81
20	54	33106	48	79	99	39607
21	82	33	75	36406	38026	34
22	31509	61	34802	33	53	61
23	37	88	29	60	80	88
24	64	33216	57	87	38107	39714
25	92	43	84	36514	33	41
26	31620	70	34911	41	61	68
27	47	98	38	68	87	94
28	75	33325	66	95	38214	39821
29	31702	53	93	36623	41	48
30	30	80	35020	50	68	74

D	18	19	20	21	22	23
M	Parts	Parts	Parts	Parts	Parts	Parts
31	31758	33408	25047	36677	38295	39901
32	85	35	75	36704	38322	28
33	31831	62	35102	31	48	54
34	40	90	29	58	75	81
35	68	33517	56	85	38401	40008
36	95	45	84	36812	29	34
37	31923	72	35211	39	56	61
38	51	99	38	66	83	88
39	78	33627	65	93	38510	40114
40	32006	54	93	36920	36	41
41	33	82	35320	47	63	68
42	61	33709	47	74	90	94
43	88	36	74	37001	38617	40221
44	32116	63	35401	28	44	48
45	43	91	29	55	71	74
46	71	33819	56	82	97	49301
47	99	46	83	37109	38724	27
48	32226	73	35510	36	51	54
49	54	33901	37	63	78	81
50	81	28	75	90	38805	40407
51	32309	55	92	37217	31	34
52	36	83	35619	44	58	60
53	64	34010	46	71	85	87
54	91	37	73	98	38912	40514
55	32419	65	35700	37325	49	40
56	46	92	28	46	65	67
57	74	34119	55	79	92	93
58	32501	47	82	37406	39019	40620
59	29	74	35809	33	46	47
60	56	34202	36	60	73	73



D	18	19	20	21	22	23
M	Parts	Parts	Parts	Parts	Parts	Parts
1	30929	32584	34229	35863	37487	39909
2	57	32611	56	91	37514	39126
3	84	39	84	35918	41	53
4	3012	66	34311	45	68	80
5	39	94	38	72	95	39206
6	67	32721	65	99	37622	33
7	95	49	93	36029	49	60
8	31122	76	34420	53	76	87
9	50	32804	47	81	37703	39313
10	78	31	75	36108	30	40
11	31205	59	34502	35	57	67
12	33	86	29	62	84	94
13	61	32914	57	89	37811	39420
14	88	41	84	36216	37	47
15	31316	69	34611	43	64	74
16	44	96	39	70	91	39501
17	71	33023	66	98	37918	27
18	99	51	93	36325	45	54
19	31426	78	34720	52	72	81
20	54	33106	48	79	99	39607
21	82	33	75	36406	38026	34
22	31509	61	34802	33	53	61
23	37	88	29	60	80	88
24	64	33216	57	87	38107	3974
25	92	43	84	36514	33	41
26	31620	70	34911	41	60	68
27	47	98	38	68	87	94
28	75	33325	66	95	38214	39821
29	31702	53	93	36623	41	48
30	30	80	35020	50	68	74

D	18	19	20	21	22	23
M	Parts	Parts	Parts	Parts	Parts	Parts
31	31758	33408	25047	36677	38295	39901
32	85	35	75	36704	38322	28
33	31831	62	35102	31	48	54
34	40	90	29	58	75	81
35	68	33517	56	85	38401	40008
36	95	45	84	36812	29	34
37	31923	72	35211	39	56	61
38	51	99	38	66	83	88
39	78	33627	65	93	38510	40114
40	32006	54	93	36920	36	41
41	33	82	35320	47	63	68
42	61	33709	47	74	90	94
43	88	36	74	37001	38617	40221
44	32116	63	35401	28	44	48
45	43	91	29	55	71	74
46	71	33819	56	82	97	49301
47	99	46	83	37109	38724	27
48	32226	73	35510	36	51	54
49	54	33901	37	63	78	81
50	81	28	75	90	38805	40407
51	32309	55	92	37217	31	34
52	36	83	35619	44	58	60
53	64	34010	46	71	85	87
54	91	37	73	98	38912	40514
55	32419	65	35700	37325	49	40
56	46	92	28	46	65	67
57	74	34119	55	79	92	93
58	32501	47	82	37406	39019	40620
59	29	74	35809	33	46	47
60	56	34202	36	60	73	73



D	24	25	26	27	28	29
M	Parts	Parts	Parts	Parts	Parts	Parts
1	40707	42288	43863	45424	46972	48506
2	26	42314	89	50	98	31
3	53	40	43915	76	47024	57
4	79	67	41	45502	49	82
5	40806	93	67	28	75	48608
6	33	42419	93	54	47101	33
7	59	46	44020	80	26	58
8	86	72	46	45606	52	84
9	40912	98	72	32	78	48709
10	39	42525	98	58	47203	35
11	65	51	44124	83	29	60
12	92	77	50	45709	55	85
13	41018	42604	76	35	80	48811
14	45	30	44202	61	47306	36
15	71	56	28	87	31	62
16	98	83	54	45813	57	87
17	41124	42709	81	39	83	48912
18	51	35	44307	64	47408	38
19	77	62	33	90	34	63
20	41204	88	59	45916	60	88
21	30	42814	85	42	85	49014
22	57	40	44411	68	47511	39
23	83	67	37	94	36	65
24	41310	93	63	46019	62	90
25	36	42919	89	45	88	49115
26	63	46	44515	71	47613	41
27	89	72	41	97	39	66
28	41416	98	67	46123	64	91
29	42	43024	93	49	90	49217
30	69	51	44619	74	47715	42

D	24	25	26	27	28	29
M	Parts	Parts	Parts	Parts	Parts	Parts
31	41495	43077	44645	46200	47741	49267
32	41522	43103	71	26	67	92
33	48	29	97	52	92	49318
34	75	56	44723	78	47818	43
35	41601	82	49	46303	43	68
36	28	43208	75	29	69	94
37	54	34	44801	55	49	49419
38	80	61	27	81	47920	44
39	41707	87	53	46406	45	70
40	33	43313	79	32	71	95
41	60	39	44905	58	96	49520
42	86	65	31	84	48022	45
43	41813	92	57	46509	47	71
44	39	43418	83	35	73	96
45	65	44	45009	61	98	49621
46	92	70	35	87	48124	46
47	41918	96	61	46612	49	72
48	45	43523	87	38	75	97
49	71	49	45113	64	48200	49822
50	98	75	39	90	26	47
51	42024	43601	65	46715	51	73
52	50	27	91	41	77	98
53	77	54	45317	67	48302	49823
54	42103	80	43	92	28	48
55	29	43706	69	46818	53	73
56	56	32	95	44	79	99
57	82	58	45321	70	48404	49924
58	42209	84	47	95	30	49
59	35	43810	73	46921	55	74
60	61	37	99	47	80	50000



D	30	31	32	33	34	35
M	Parts	Parts	Parts	Parts	Parts	Parts
1	50025	51528	53016	54488	55943	57381
2	50	53	41	54512	66	57405
3	75	78	65	37	91	29
4	50100	51603	90	61	56015	52
5	25	28	53115	85	39	76
6	51	53	39	54610	63	57500
7	76	78	64	34	87	24
8	50201	51703	89	58	56112	48
9	26	28	53213	83	36	71
10	51	52	38	54707	60	95
11	76	77	63	31	84	57619
12	50302	51802	87	56	56208	43
13	27	27	53312	80	32	67
14	52	52	36	54804	56	98
15	77	77	61	29	80	57714
16	50402	51902	86	53	56304	38
17	27	27	53410	77	28	62
18	52	51	35	54902	52	85
19	77	76	59	26	76	57809
20	50502	52001	84	50	56400	33
21	28	26	53508	75	24	56
22	53	51	33	99	48	80
23	78	76	58	55023	72	57904
24	50603	52100	82	48	96	28
25	28	25	53607	72	56520	51
26	53	50	31	96	44	75
27	78	75	56	55120	68	99
28	50703	52200	80	45	92	58022
29	28	25	53705	69	56616	46
30	53	49	29	93	40	70

D	30	31	32	33	34	35
M	Parts	Parts	Parts	Parts	Parts	Parts
31	50778	52274	53754	55217	56664	58093
32	50803	99	79	42	88	58117
33	29	52324	53803	66	56712	41
34	54	49	28	90	36	64
35	79	73	52	55314	60	88
36	50904	98	77	39	84	58212
37	29	52423	53901	63	56808	35
38	54	46	26	87	32	59
39	79	72	50	55411	56	83
40	51004	97	75	36	80	58306
41	29	52522	99	60	56904	30
42	54	47	54024	84	27	54
43	79	71	48	55508	51	77
44	51104	96	72	32	75	58401
45	26	52621	97	57	99	24
46	54	46	54121	81	57023	48
47	79	70	46	55605	47	72
48	51204	95	70	29	71	95
49	29	52720	95	53	95	58519
50	54	45	54219	77	55119	42
51	79	69	44	55702	42	66
52	51304	94	68	26	66	90
53	29	52819	93	50	90	58613
54	54	43	54317	74	57214	37
55	79	68	41	98	38	60
56	51404	93	66	55822	62	84
57	28	52917	90	46	86	58707
58	53	42	54415	71	57309	31
59	68	77	39	95	33	54
60	51503	91	63	55919	57	78



D	36	73	38	39	40	41
M	Parts	Parts	Parts	Parts	Parts	Parts
I	58802	60204	61589	62954	64301	65627
2	25	27	61611	77	23	49
3	49	51	34	99	45	71
4	72	74	57	63022	67	93
5	96	97	80	45	90	65715
6	58919	60320	61703	67	64412	35
7	43	44	26	90	34	59
8	66	67	49	63112	56	81
9	90	90	72	35	79	65803
10	59013	60413	95	57	64501	25
11	37	36	61817	80	23	47
12	60	59	40	63202	45	68
13	84	38	63	25	67	90
14	59107	60506	86	48	90	95912
15	30	29	61909	70	64612	34
16	54	52	32	93	34	56
17	77	75	55	63315	56	78
18	59201	98	77	38	78	66000
19	42	60621	62000	60	64701	22
20	48	45	23	83	23	43
21	71	68	46	63405	45	65
22	95	91	69	28	67	87
23	59318	60714	91	50	89	66109
24	41	37	62114	73	64811	31
25	65	60	37	95	34	53
26	88	83	60	63518	56	74
27	59412	60806	83	40	78	96
28	35	29	62205	62	64900	66318
29	58	53	28	85	22	40
30	82	76	51	63607	44	60

D	36	37	38	39	40	41
M	Parts	Parts	Parts	Parts	Parts	Parts
31	59505	60899	62274	63630	64966	66283
32	29	60922	96	52	89	66305
33	52	45	62319	75	65011	27
34	75	68	42	97	33	49
35	99	91	65	63719	55	70
36	59622	61014	87	42	77	92
37	45	37	62410	64	99	66414
38	69	60	33	87	65121	36
39	92	83	56	63809	43	57
40	59715	61106	78	32	65	79
41	39	29	62501	54	87	66510
42	62	52	24	76	65209	23
43	85	75	46	99	31	44
44	59809	98	69	63921	53	66
45	32	61221	92	43	75	88
46	55	44	62615	66	98	66609
47	79	67	37	88	65320	31
48	59902	90	60	64010	42	53
49	25	61313	83	33	4	74
50	48	36	62705	55	86	96
51	72	59	28	77	65408	66718
52	95	82	51	64100	30	39
53	60018	61405	73	22	52	61
54	42	28	69	44	74	83
55	65	51	62818	67	96	66804
56	88	74	41	89	65518	26
57	60111	97	64	64211	40	48
58	35	61520	86	34	61	69
59	58	43	62909	56	83	91
60	81	66	32	78	65605	66913



D	42	43	44	45	46	47
M	Parts	Parts	Parts	Parts	Parts	Parts
1	66934	68221	69486	70731	71954	73155
2	56	42	69507	51	74	75
3	77	63	28	72	94	94
4	99	84	49	92	72014	73214
5	67021	68306	70708	13	34	34
6	42	27	91	33	55	54
7	64	48	69612	54	75	74
8	85	70	33	75	95	93
9	67107	91	53	95	72115	73313
10	28	86412	74	70916	35	33
11	50	33	95	36	55	53
12	72	45	69716	67	75	72
13	93	75	37	77	96	92
14	67215	97	58	98	72216	73412
15	36	68518	79	71018	26	32
16	58	39	96	39	56	51
17	79	60	66820	59	76	71
18	67301	81	41	79	96	91
19	22	68603	62	71100	72316	73501
20	44	24	83	20	36	30
21	65	45	69903	41	56	50
22	87	66	24	61	77	70
23	67408	87	45	81	97	90
24	30	68708	66	71202	72417	73609
25	51	29	87	23	37	29
26	73	51	70007	43	57	49
27	94	72	28	63	77	68
28	67516	93	49	84	97	88
29	37	68814	70	71304	72517	73708
30	59	35	90	25	37	27

D	42	43	44	45	46	47
M	Parts	Parts	Parts	Parts	Parts	Parts
31	97580	68856	70111	71345	72557	73747
32	67601	77	32	65	77	67
33	23	98	53	86	97	86
34	44	68919	73	71406	72617	73806
35	66	40	94	26	37	25
36	87	61	70215	47	57	45
37	67709	83	36	67	77	65
38	30	69004	56	87	97	84
39	51	25	77	71508	72717	73904
40	73	46	98	28	37	23
41	94	67	70318	48	57	43
42	67815	88	39	69	77	63
43	37	69109	60	89	97	82
44	58	30	80	71609	72817	74002
45	80	51	70401	30	37	21
46	67901	72	22	50	57	41
47	22	93	42	70	76	60
48	44	69214	63	91	96	80
49	65	35	84	71711	72916	74100
50	86	56	70504	31	36	19
51	68008	77	25	51	56	39
52	29	98	45	72	76	58
53	50	69319	66	92	96	78
54	73	40	87	71812	73016	97
55	94	61	70607	32	36	74217
56	68114	82	28	53	55	36
57	35	69403	48	73	75	56
58	56	23	66	93	95	75
59	78	44	90	71913	73115	95
60	99	65	70710	33	53	74314



D	48	49	50	51	52	53
M	Parts	Parts	Parts	Parts	Parts	Parts
1	74333	75490	76623	77732	78818	79881
2	53	75509	41	51	36	98
3	72	28	60	69	54	79916
4	92	47	79	87	72	33
5	74411	66	97	77806	90	51
6	31	85	76716	24	78908	68
7	50	75604	35	42	26	85
8	70	23	53	60	44	80003
9	89	42	72	79	61	20
10	74508	61	91	97	79	38
11	28	80	76809	77915	97	55
12	47	99	28	33	79015	73
13	66	75718	46	52	33	90
14	86	37	65	70	51	80107
15	74605	56	84	88	68	25
16	25	75	76902	78006	86	42
17	44	94	21	24	79104	60
18	63	75813	39	43	22	77
19	83	32	58	61	40	94
20	74702	51	77	79	57	80212
21	21	70	95	97	75	29
22	41	89	77014	78115	93	47
23	60	75908	32	33	79211	64
24	79	27	51	52	28	81
25	99	46	69	70	46	99
26	74818	64	88	88	64	80326
27	37	83	77106	78206	82	33
28	57	76002	25	24	99	51
29	76	21	43	42	79317	68
30	95	12	62	60	35	85

D	48	49	50	51	52	53
M	Parts	Parts	Parts	Parts	Parts	Parts
31	74914	76059	77180	78278	79353	80402
32	34	78	99	97		20
33	53	97	77217	78315	88	37
34	72	76116	36	33	79406	54
35	91	43	54	51	23	72
36	75011	53	73	69	41	89
37	30	72	91	87	59	80506
38	49	91	77310	78405	76	23
39	68	76210	28	23	94	41
40	88	29	47	41	79512	58
41	75107	48	65	59	29	75
42	26	66	84	77	47	92
43	45	85	77402	95	64	80610
44	64	76304	20	78513	82	27
45	83	23	39	31	79600	44
46	75203	42	57	49	17	61
47	22	60	76	67	35	78
48	41	79	94	85	52	96
49	60	98	77512	78603	70	80713
50	79	76417	31	21	88	30
51	99	35	49	39	79705	47
52	75318	44	67	57	23	64
53	37	73	86	75	40	81
54	56	92	77604	93	85	98
55	75	76510	22	78711	75	80816
56	94	29	41	29	93	33
57	75413	48	59	47	79811	50
58	32	67	77	65	28	67
59	51	85	96	83	46	84
60	70	76604	77714	78801	63	80901



D	54	55	56	57	58	59
M	Parts	Parts	Parts	Parts	Parts	Parts
1	80918	81931	82920	83882	84810	85731
2	35	48	36	98	35	46
3	52	65	52	83914	51	61
4	70	81	68	30	66	76
5	87	98	85	46	81	91
6	81004	82015	83001	61	97	85806
7	21	31	17	77	84912	21
8	38	48	33	93	27	36
9	55	65	49	84009	43	51
10	72	81	66	25	58	66
11	89	98	82	40	73	81
12	81106	82114	98	56	89	96
13	23	31	83115	72	85004	85910
14	40	48	30	88	91	25
15	57	64	46	84103	35	40
16	74	81	63	19	50	55
17	91	97	79	35	65	70
18	81208	82214	95	51	81	85
19	25	30	93211	66	96	86000
20	42	47	27	82	85111	14
21	59	64	43	98	26	29
22	76	80	59	84213	42	44
23	93	97	76	29	57	59
24	81310	82313	92	54	72	74
25	27	30	83308	60	87	89
26	43	46	24	76	85203	86103
27	60	63	40	92	81	18
28	77	79	65	84370	33	33
29	94	96	72	23	48	48
30	81411	82412	88	39	64	62

D	54	55	56	57	58	59
M	Parts	Parts	Parts	Parts	Parts	Parts
31	81428	82429	83404	84354	45279	86177
32	45	45	20	70	94	92
33	62	62	36	86	85309	86207
34	79	78	52	84401	24	21
35	95	94	68	63	39	36
36	81512	82511	84	32	55	51
37	26	27	83500	48	70	66
38	46	44	16	63	85	80
39	63	60	32	79	85400	95
40	80	77	48	95	15	86310
41	96	93	64	84510	30	24
42	81613	82609	80	26	45	39
43	30	26	96	41	60	54
44	47	42	83612	57	76	68
45	64	58	28	72	91	83
46	80	75	44	88	85506	98
47	97	91	60	84603	21	86412
48	81714	82708	76	19	36	27
49	31	24	92	34	51	42
50	48	40	83708	50	66	56
51	64	57	24	65	81	71
52	81	73	40	81	69	58
53	98	89	55	96	85611	86500
54	81814	82806	71	84712	26	15
55	31	22	87	27	41	29
56	48	38	83803	34	56	44
57	65	54	19	58	71	58
58	81	71	35	73	86	73
59	98	87	51	89	85701	87
60	81915	82903	67	84804	16	86602



D	60	61	62	63	64	65
M	Parts	Parts	Parts	Parts	Parts	Parts
1	86617	87476	88308	89113	89892	90643
2	31	90	22	27	89904	55
3	90	87504	35	40	17	67
4	60	18	88349	53	30	79
5	75	32	62	89166	43	92
6	89	87546	76	79	89955	90704
7	86404	60	90	92	68	16
8	18	74	88403	89206	81	28
9	33	88	17	19	93	41
10	47	87602	30	32	90006	90753
11	62	16	44	45	19	65
12	76	30	88458	89258	31	77
13	91	44	71	71	44	89
14	86805	87658	85	84	90057	90802
15	19	72	98	97	69	14
16	34	86	88512	89310	82	26
17	48	87700	25	24	95	38
18	63	14	39	37	90107	90850
19	77	28	52	50	20	62
20	91	42	88566	89363	32	75
21	86906	87756	79	76	45	87
22	20	70	93	89	98158	99
23	35	84	88606	89402	70	90911
24	49	98	20	15	83	23
25	63	87812	33	28	95	35
26	78	26	47	41	90208	47
27	92	40	88660	89454	20	90959
28	87006	53	74	67	33	71
29	21	67	87	80	46	84
30	35	87881	88701	89493	90258	96

D	60	61	62	63	64	65
M	Parts	Parts	Parts	Parts	Parts	Parts
31	87049	87895	88714	89506	90271	91008
32	64	87909	27	19	83	20
33	78	23	41	32	96	32
34	92	37	54	45	90308	44
35	87107	51	88768	89558	21	91056
36	21	87964	81	71	33	68
37	35	78	94	84	46	80
38	94	92	88808	97	90358	92
39	64	88006	21	80609	70	91104
40	87	20	35	32	83	16
41	92	33	48	35	95	28
42	87206	47	88861	48	90408	40
43	21	88061	75	89661	20	91162
44	35	75	88	74	33	64
45	49	89	88901	87	45	76
46	63	88102	15	89700	90457	88
47	78	16	28	12	70	91200
48	92	30	41	25	82	13
49	87306	44	88954	38	95	23
50	20	88157	68	89751	90507	35
51	34	71	81	64	19	91247
52	48	85	94	77	32	59
53	63	98	89008	89	44	71
54	77	88212	21	89802	90556	83
55	91	26	34	15	69	95
56	87405	40	47	28	81	91307
57	19	53	89060	41	93	19
58	33	88267	74	89853	90606	30
59	47	81	87	66	18	42
60	61	94	89100	79	30	91354



D	66	67	68	69	70	71
M	Parts	Parts	Parts	Parts	Parts	Parts
1	91366	92061	92729	93368	93979	94561
2	78	73	40	78	89	70
3	90	84	51	89	99	80
4	91401	95	61	99	94009	89
5	13	92107	62772	93410	18	99
6	25	18	83	20	28	94608
7	37	29	94	30	38	17
8	91448	41	92805	41	48	27
9	60	92152	16	93451	94058	36
10	72	63	26	61	68	47
11	84	75	37	72	78	94655
12	95	86	92848	82	88	64
13	91507	97	59	92	97	74
14	19	92208	70	93503	94107	83
15	31	20	80	13	17	93
16	42	31	91	23	27	94702
17	91554	42	92902	34	37	11
18	66	92253	13	93544	74	21
19	77	65	24	54	94156	30
20	89	76	34	64	66	39
21	91601	87	92945	75	76	94748
22	12	98	56	83	86	58
23	24	92309	66	95	95	67
24	37	21	77	93605	94205	76
25	91647	32	88	16	15	86
26	59	43	99	26	25	95
27	71	92354	93009	36	34	94804
28	82	65	20	46	44	13
29	94	76	31	57	94254	23
30	91706	92387	93041	67	64	32

D	66	67	98	69	70	71
M	Parts	Parts	Parts	Parts	Parts	Parts
31	91717	92399	93052	93677	94273	94841
32	29	92410	62	87	83	50
33	40	21	73	97	93	60
34	52	32	84	93707	94302	69
35	91763	43	94	18	12	94878
36	75	92454	93105	28	22	87
37	87	65	16	38	31	95
38	98	76	26	93748	41	94905
39	91810	87	37	58	94351	15
40	21	98	93147	68	60	24
41	33	92509	58	78	70	33
42	44	20	69	88	80	42
43	91856	32	79	98	89	51
44	67	43	90	93809	99	94960
45	79	92554	93200	19	94408	69
46	90	65	11	29	18	79
47	91902	76	21	39	28	88
48	13	87	32	93849	37	97
49	24	98	93242	59	47	95006
50	36	92609	53	69	94456	15
51	91947	20	63	79	66	42
52	59	30	74	89	75	33
53	70	41	84	99	86	42
54	82	92652	95	93909	94	51
55	39	63	93305	19	94504	95060
56	92004	74	16	29	13	69
57	16	85	26	39	23	78
58	27	96	37	93949	32	87
59	39	92707	47	59	42	96
60	92050	18	93358	69	94551	95105



D	72	73	74	75	76	77
M	Parts	Parts	Parts	Parts	Parts	Parts
1	95114	95638	96134	96600	97036	97443
2	23	47	42	07	43	50
3	32	55	50	15	50	96
4	41	64	58	22	75	63
5	50	95672	66	30	64	69
6	95159	81	74	37	97071	76
7	68	89	82	45	78	82
8	77	98	90	52	85	89
9	86	95706	98	60	92	95
10	95	15	96205	67	99	97502
11	95204	23	13	74	97106	08
12	12	31	21	82	13	14
13	21	40	29	89	20	21
14	30	95748	37	97	27	27
15	39	57	96145	96704	34	97534
16	95248	65	53	11	97141	40
17	57	73	61	19	48	47
18	66	95782	69	26	54	53
19	74	90	96277	34	61	59
20	83	98	84	96741	97168	97566
21	92	95807	92	48	75	72
22	95301	15	96300	56	82	78
23	10	23	08	63	89	85
24	19	32	16	70	96	91
25	27	40	24	96778	97202	98
26	36	95848	95331	85	09	97604
27	45	57	39	92	16	10
28	54	65	48	96800	23	16
29	62	73	55	07	30	23
30	95371	95881	96363	14	97236	97629

D	72	73	74	75	76	77
M	Parts	Parts	Parts	Parts	Parts	Parts
31	95380	95890	96370	96822	97243	97635
32	89	98	78	29	50	42
33	97	95906	86	36	57	48
34	95406	14	94	43	64	54
35	15	23	96401	51	70	60
36	95424	31	09	96858	97277	67
37	32	39	17	65	84	97673
38	41	95947	24	72	91	79
39	50	56	32	79	97	85
40	95458	64	96440	87	97304	92
41	67	72	48	94	11	98
42	76	95980	55	96901	17	97704
43	84	88	63	08	24	10
44	93	96	96471	15	31	16
45	95501	96004	78	23	97337	23
46	10	13	86	30	44	29
47	19	21	94	96973	51	97735
48	27	29	96501	44	57	41
49	36	37	09	51	64	47
50	95545	96045	16	58	97371	53
51	53	53	24	65	77	60
52	62	61	96532	96973	84	97766
53	70	69	39	80	90	72
54	79	96077	47	87	97	78
55	95587	85	54	94	97404	84
56	96	94	62	97001	10	90
57	95604	96102	96599	08	17	96
58	13	10	77	15	23	07892
59	21	18	85	22	30	08
60	30	26	96592	97029	97437	14



D	78	79	80	81	82	83
M	Parts	Parts	Parts	Parts	Parts	Parts
1	97820	98168	98485	98773	99030	99258
2	26	73	90	77	34	61
3	32	79	95	82	38	65
4	38	84	98500	86	42	68
5	44	90	05	91	46	72
6	98850	95	10	98795	99050	99275
7	56	98201	15	98800	54	79
8	62	06	20	04	58	82
9	68	12	98525	09	62	85
10	74	17	30	13	66	89
11	97880	22	35	18	99070	99293
12	86	98228	40	98822	74	96
13	92	34	45	27	78	99300
14	98	39	98550	31	82	03
15	9794	45	55	36	86	06
16	10	50	60	40	99090	10
17	16	98255	65	98844	94	13
18	22	61	70	49	98	99317
19	28	66	98575	53	99102	20
20	97934	72	80	58	06	22
21	39	77	85	62	09	27
22	45	98282	89	98866	13	30
23	51	88	94	71	17	99333
24	57	93	99	75	99121	37
25	97963	98	98604	79	25	40
26	69	98304	09	84	29	43
27	75	90	14	98888	33	47
28	80	14	18	92	36	99350
29	86	20	23	97	40	53
30	97992	9832	98628	98901	99144	57

D	78	79	80	81	82	83
M	Parts	Parts	Parts	Parts	Parts	Parts
31	97998	98330	98633	98905	99148	99360
32	98004	36	38	10	52	63
33	09	41	42	14	55	67
34	15	46	47	18	59	70
35	21	51	52	22	63	73
36	27	98357	98657	98927	99167	99376
37	98032	62	61	31	70	80
38	38	67	66	35	74	83
39	44	72	71	39	78	86
40	50	78	76	44	82	89
41	55	98383	98680	98948	99185	99392
42	98061	88	85	52	89	96
43	67	93	90	56	93	99
44	72	98	94	60	96	99402
45	78	98404	99	65	99200	05
46	84	09	98704	98969	04	08
47	89	14	08	73	07	11
48	95	19	13	77	11	15
49	98101	24	18	81	15	99418
50	06	98429	22	85	99218	21
51	12	34	98727	98990	22	24
52	18	40	32	94	25	27
53	23	45	36	98	29	30
54	98129	50	41	99002	33	99433
55	34	98455	45	06	99236	36
56	40	60	98750	10	40	29
57	46	65	55	14	44	43
58	51	70	59	18	47	46
59	57	75	64	22	51	99449
60	98162	98480	98768	99025	96256	52



D	84	85	86	87	88	89
M	Parts	Parts	Parts	Parts	Parts	Parts
1	99455	99622	99758	99864	99939	99985
2	58	24	60	65	40	85
3	61	27	62	67	41	86
4	64	29	64	68	42	86
5	67	32	66	70	43	87
6	99470	99934	99768	99871	99944	87
7	73	37	70	73	45	88
8	76	39	72	74	45	99988
9	79	41	74	76	46	88
10	82	44	76	77	47	89
11	99485	99646	99778	99878	99948	89
12	88	49	80	79	49	90
13	91	51	82	80	50	90
14	93	54	83	82	51	99991
15	96	56	85	83	52	91
16	99	99658	99787	99884	99953	91
17	99502	61	89	86	54	92
18	05	63	91	88	55	92
19	08	66	93	90	55	92
20	11	68	95	91	56	99992
21	14	99670	99797	99793	99957	93
22	99517	73	99	94	58	93
23	19	75	99800	95	59	94
24	22	77	02	97	60	94
25	25	80	04	98	61	94
26	28	99682	06	99	99961	99995
27	99531	84	08	99900	62	95
28	34	87	99809	02	63	95
29	36	89	11	03	64	95
30	39	91	13	99904	99964	96

D	84	85	86	87	88	89
M	Parts	Parts	Parts	Parts	Parts	Parts
31	99542	99694	99815	99905	99965	99996
32	45	96	17	07	66	96
33	47	98	18	08	67	96
34	50	99700	20	09	67	97
35	53	03	22	11	68	97
36	99556	05	99823	99912	99969	97
37	58	07	25	13	70	99997
38	61	09	27	14	70	97
39	64	99711	29	15	71	98
40	67	14	30	17	72	98
41	99569	16	99832	99918	99972	98
42	72	18	34	19	73	98
43	75	20	35	20	74	99998
44	77	99722	37	21	74	98
45	80	25	39	22	75	99
46	99583	27	99840	99924	99976	99
47	85	29	42	25	76	99
48	88	31	44	26	77	99
49	91	99733	45	27	78	99999
50	93	35	47	28	78	99
51	99596	37	99848	99929	79	99
52	98	39	50	30	80	99
53	99601	42	52	31	81	99
54	04	99744	53	32	81	99
55	06	46	55	33	82	99999
56	09	48	99856	99934	99982	99
57	11	50	58	35	83	99
58	99614	52	59	37	83	99
59	16	54	61	38	84	100000
60	19	56	62	99939	99984	100000